LECTURES ON BABIES

RALPH VINCENT

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A COURSE OF LECTURES DELIVERED AT

THE INFANTS HOSPITAL
WESTMINSTER

BY

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LONDON
BAILLIÈRE, TINDALL AND COX
8, HENRIETTA STREET, COVENT GARDEN
1908

PREFACE

THESE lectures were delivered in the Lecture Theatre of the Infants Hospital last winter.

A great deal that is said and written at the present time on the subject of infantile disease and mortality affords but little evidence of the kind of knowledge derived from study of the actual facts. My principal object, throughout the course, was to bring my audience back to first principles, to lead them to neglect vague generalities, and to encourage them to carry out their work on the basis of patient study and observation.

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1, HARLEY STREET, LONDON, W.
April, 1908.

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LECTURE I.

THE PRESENT CONDITIONS OF INFANT LIFE, AND THEIR MEANING.

BEFORE embarking upon the lectures dealing more especially with our main subject, I propose this afternoon to direct your attention to some very important considerations which are essential to its study. There is a great lack of proportion and of balance in much that is said concerning the condition of infants throughout the country; and as it is of paramount importance for anyone who wishes really to study the subject to differentiate between the essential and the non-essential, it will be my especial object to lay before you the chief aspects in which infant mortality is a danger to this country. And I should like at once to remind you that there are two phases in regard to the mortality of infants.

In the first place it is a necessary and beneficent check upon the rearing of infants born in a condition of disease, imperfect development, or structural deficiency. As illustrations, I may quote (1) premature infants, so imperfectly developed at the time of

birth as to be incapable of normal development; (2) infants suffering from the effects of specific constitutional disease; and (3) infants suffering from defects, such as absence of limbs, and other conditions inconsistent with the development of a sound mind in a sound body. However much we may regret these deaths, we must, all of us, admit that so far as the national point of view is concerned, and very largely so far as the infants themselves are concerned, all infants coming within these categories are better dead.

The other phase concerns the mortality among infants born in a condition of health, and capable of normal healthy development in a sufficiently favourable environment.

One of the first questions, therefore, for us to determine is, what proportion exists between the babies born defective and diseased, and those born healthy. And I will draw your attention to my own practical experience when I was Resident Medical Officer at Queen Charlotte's Lying-in Hospital. I draw your attention particularly to that hospital, because if there is any hospital in which we should expect infants to be born in a defective condition, owing to the condition of the mother, it would be that hospital. Three-quarters of the mothers admitted to the hospital are unmarried women. During pregnancy they suffer from very arduous conditions, they are in homes where they have to do heavy laundry work, and, as a matter of fact, they are all, practically speaking, anæmic, and exhibit signs of weakness and exhaustion.

What is the condition, as a general rule, of the infants born in Queen Charlotte's in these circumstances? The answer is that the vast majority of them are perfectly healthy, vigorous infants. We conducted very careful inquiries in the hospital, not merely observing the weight, but taking, very systematically, the measurements in regard to the length of the trunk, the circumference of the head, and other observations, with the result that there can be no question of the vigour of the infants born in that hospital, although the mothers are in the unfortunate circumstances I have described.

That is no exceptional experience. I would ask you to listen to the evidence given before the Inter-Departmental Committee on Physical Deterioration, by Dr. Eichholz, one of His Majesty's Inspectors of Schools. He says:

'To discuss more closely the question of heredity, may I, in the first instance, recall a medical factor of the greatest importance: the small percentage of unhealthy births among the poor—even down to the very poorest. The number of children born healthy is, even in the worst districts, very great. The exact number has never been the subject of investigation, owing largely to the certainty which exists on the point in the minds of medical men, but it would seem to be no less than 90 per cent. I have sought confirmation of my view with medical colleagues in public work—*e.g.*, public health, poor law, Factory Acts, education, and in private practice in poor areas, and I have also consulted large maternity charities, and have always been strengthened in this view. In no single case has it ever been asserted that ill-nourished or unhealthy babies are more frequent at

the time of birth than among the rich, or that hereditary diseases affect the new-born of the rich and the poor unequally. The poorest and most ill-nourished women bring forth as hale and strong-looking babies as those in the very best conditions. In fact, it almost appears as though the unborn child fights strenuously for its own health at the expense of the mother, and arrives in the world with a full chance of living a normal physical existence.'

I will quote you one more piece of evidence—this time the evidence of Dr. Malins, President of the Obstetrical Society at the time he gave his evidence. I will put the question asked by the chairman first. He said:

'It was said by Dr. Eichholz, on the authority of other medical men, that if people are going to have children, they will have healthy children, as though Nature were giving every generation a fresh start, and he went on to say that healthy births were about 90 per cent. in the poor neighbourhoods, and he suggested we should go to the London Obstetrical Society to ascertain how far their experience bore out his statements. What are you able to say on this point?'

This is Dr. Malins' reply:

'What I have to say at the present time is more a matter of observation and opinion. We have not the figures at present to prove the accuracy of it, but I think the testimony of experienced observers would be in accordance with the views expressed by Dr. Eichholz, though perhaps not to such a large extent. I should say that from 80 to 85 per cent. of children are born physically healthy.'

That, of course, is an extremely important question to determine, and I have given you the evidence of these two gentlemen, which is so conclusive, because without that we cannot go much further. But in Dr. Eichholz's evidence there is one point which is interesting, because it shows that, although his testimony is perfectly sound, he appeared to be in some doubt as to the reason. He refers particularly to the unborn child fighting strenuously for its own health. On that point there is no mystery, and it is so important in reference to other phases of the question which I shall discuss, that it is necessary to dwell for a moment upon this question.

From the time that the infant begins to develop, you must remember that, physiologically speaking, it is an organism entirely independent of the mother, and its whole motive of being is to obtain food materials for its own development from the tissues of the mother. It has enormous potential vigour—enormously greater than that of the mother—and although the mother may suffer from exhaustion, the unborn infant does not. That is a first law of Nature, and, were it not so, the reproduction of the species would soon come to an end. To illustrate the relation between the unborn infant and its mother, I may compare it with the fungus on a tree. The tree may sicken, but the fungus flourishes.

I am now in a position to ask your attention to the chief factors of the death-rate among infants. I will take the year 1900 as being a representative year, and I want you to follow these figures, because they will illustrate several rather important factors. These

are the registered deaths in England and Wales for the year 1900:

From birth to three months	...	68,820
From three to six months	...	30,283
From six to twelve months	...	43,809
From one to two years ...	...	37,240

Let it be allowed at once that the first line—from birth to three months—includes the congenitally defective babies who are better dead. I think you will allow that, practically speaking, all the babies suffering from congenital deficiency must be included in this first line, because it would be rather ridiculous to speak of babies as suffering from congenital defects inconsistent with life, if they survived more than three months. If we allow, then, 30,000 as due to conditions at birth—a somewhat large allowance—we are still faced with 38,000 in this column. But this first column is not the most important. From three to six months there are 30,283 deaths; from six to twelve months, 43,809 deaths; and from one to two years you see the high proportion of deaths that is maintained. Contrast these with the deaths in childhood: From two to three years they amount to 13,973; from three to four years, 9,122; from four to five years, 6,713.

We have, therefore, to find some factor which can account for this enormous infantile mortality. It cannot be accounted for by conditions at birth, and there is no question as to the cause of death. It is a very simple one—absence of food adequate in quality for the physiological requirements of infant life.

Dr. Hall dealt with the most serious question of all when, in the year 1903, he examined 2,335 Board School children in the city of Leeds and the neighbourhood. He found more than half of these children suffering from rickets, and considerably more than half had decaying or badly developed teeth. And it is to this phase of our subject that I now wish to direct your attention. However great the mortality may be, it is not so serious a question, from the national point of view, as is the condition of the babies, who, suffering from the conditions responsible for this mortality, manage to survive in a condition of hopeless malnutrition. I will give you a brief list of the conditions as they affect children to-day.

Rickets is to be observed in every town—large and small—in an enormous proportion of the population. I have quoted Dr. Hall's observations at Leeds. Regarding the mentally defective children who are requiring so much of our attention to-day, there is not the smallest question that infantile malnutrition is the primary cause of their condition. Physical and mental deficiencies of all possible kinds are caused by this malnutrition, and the lunatic asylums are being filled with its results. Striking illustrations of the effects of malnutrition in infancy may be seen in the hospitals for scarlet fever and measles. As a rule, a healthy child infected with measles or scarlet fever, suffers for a time during the acute state of the disease, and then makes a complete recovery, so that it is not uncommon to hear a mother say that the child seems all the better for it. On the other hand, when you are dealing with a child who has been the

victim of infantile malnutrition, the picture is altogether different. The resistance to disease, the power of combating the disease, is largely or entirely lost, and instead of the infant making a good recovery, it becomes the victim of all kinds of complications and sequelæ, such as cerebral disease, middle-ear disease, and the like. If those of you who have the opportunity of watching these cases, will take, on the one hand, the instances of middle-ear disease, and all such complications in which the ear or brain or the bones are attacked; and will at the same time note whether these children exhibit signs of malnutrition and rickets, I have not the smallest hesitation in predicting the result of your observations. In the vast majority of cases it is the infants suffering from deformities, from malnutrition, who will suffer from the complications I have referred to.

Let me illustrate the same thing by drawing your attention to hospitals for diseases of the chest, particularly pulmonary tuberculosis. You will find that the vast proportion of adults, young adults about twenty-five years of age, suffering from phthisis, exhibit obvious and clear signs of rickets affecting the chest. Rickets is the cause, the primary cause, of their condition, because it injures the chest wall, prevents the expansion of the lungs, diminishes the resistance of all the tissues, and the bacillus of tuberculosis simply plays the part of an infecting agent, which the young adult, by reason of his weakened condition, can no longer resist. If it were true that the tubercle bacillus was capable of affecting healthy adults, and inducing the lesions of

tuberculosis in the healthy chest, none of us would be safe, and the whole population would be destroyed in a very short time. The whole question of tuberculosis is a question, on the one hand, of the bacillus, on the other hand, of your resistance to it; and the reason for the prevalence of tuberculosis is simply that the resistance of individuals is weakened to such an extent that they have no longer any adequate power to combat the inroads of pathogenic organisms.

I select one other illustration which is only too obvious to-day, and that is the condition of the teeth. At the time of birth the teeth—the primary teeth—are fully developed in the jaw of the infant. They have not erupted, but they exist fully made in the gums. Directly we find any condition affecting the growth of the bone, affecting the structure of the tissues, we find at once that the eruption of the teeth is interfered with and delayed. And I cannot impress upon you too strongly the terrible injury that results in all cases where there is delay and irregularity in the appearance of the first teeth. It is not so much any question of the condition of the primary teeth when they erupt, because the real injury is to the second teeth, which are to follow. Unless the milk teeth follow a perfectly normal course of development, the formation of the enamel germ of the second dentition is interfered with. The result is that a series of pathological processes are started within a few months of the birth of the infant, with the consequence that the second teeth are badly formed, very inadequate in structure, and deficient

in the hard enamel, which is a protection against the inroad of all kinds of organisms, acids, and other destructive agents. In order to find a cure for the present condition of the teeth in all classes, you will have to go back to the young infants, and see that they get their first teeth at the proper time and in proper order.

Now, I should like to quote to you some evidence with regard to the influence of food as distinguished from other causes, and I will again quote to you the evidence of Dr. Eichholz before the Inter-Departmental Committee:

'I hold a very firm opinion, which is shared by medical men, members of education committees, managers, teachers, and others conversant with the conditions of school children, that food is at the base of all the evils of child degeneracy—that is to say, if we can take steps to ensure the proper adequate feeding of the children, the evil will rapidly cease. Other circumstances noted in connexion with degeneracy are: bad clothing, bad boots, exposure, want of fresh air, overcrowding, filth, etc. But all these pale beside the stress laid upon food. As to overcrowding and dirt, they are secondary circumstances compared with food, for many of the Jewish immigrants and the Irish contribute their full share to the difficulties of the sanitary authorities in dealing with dirt and overcrowding. Yet these two sections of population make a great point of caring for their young children, with the result that these two types very usually stand apart in the poorer neighbourhoods from the general degeneracy.'

You see that Dr. Eichholz refers to the Jewish population, and I will now draw your attention to a

remarkable observation by Dr. Hall, of Leeds, in confirmation of this statement. He conducted an examination in a very poor school at Leeds, and he found that 50 per cent. of the children were suffering from rickets. He then went to an equally poor school in the same town, which, however, was a Jewish school, and he found only 7 per cent. were suffering from rickets. As a matter of fact, in this country to-day it is the Jewish infants, as a rule, who do not suffer from malnutrition, the great reason being that the Jewish mothers do not go out to work; they stop at home and nurse their infants. For there is a powerful tradition in regard to maternal duties, the husbands seldom calling upon women to undertake work inconsistent with those duties. The fact, therefore, that there are sections of the community oppressed by poverty, living under insanitary conditions, but yet, on the whole, free from the incidence and consequences of malnutrition, points conclusively to the cause of illness and death among the infants among which malnutrition is found. It is not to be explained by absence of sanitation, but by the absence of the food requisite for structure and development during infancy.

The first great cause of the conditions which I have been discussing is the absence of maternal nursing. And we must bear in mind the precise conditions responsible for this. Earlier in my lecture I was at some pains to explain that the whole efforts of Nature were on the side of the unborn infant. The mother may suffer, but, as a general rule, the baby will be born healthy. With the birth of the

infant the state of affairs is completely reversed. If, in point of fact, as the result of the stress of pregnancy, the mother is suffering from exhaustion, is anæmic, weak, and in general ill-health, then you may be quite certain that the task of providing food for her infant is, or soon will be, quite beyond her powers. I lay great stress on this, because any attempts on our part to deal with this question by caring for the mothers *after* the birth of the infant will be of little avail. The first essential to a mother's maintaining successful nursing is that during the whole of her pregnancy her health is maintained at the best possible standard. This is a question that has not received very much attention. After the babies are born mothers are bombarded with leaflets of all kinds, instructing them what to do and how to act; but, for the reasons I have given you, the first thing to do is to preserve the good health of the mother during pregnancy.

In the next place, it is absolutely essential that her occupation and environment during nursing should be consistent with the maintenance of breast-feeding. If she has to go out to work in the day, it is perfectly hopeless for her to undertake it. Many mothers do, in fact, maintain a sort of spasmodic feeding of the baby in the intervals of coming from and going to work, and it is worth while to draw your attention to the impossibility of the milk under such conditions being of any avail to the infant. Not only does the irregularity of feeding upset the infant, but it altogether alters the character of the milk. *Regularity* of nursing is not only

essential from the point of view of the infant's digestion, but it is also of the greatest possible importance in regard to the character of the milk. If the mother nurses every two hours, the milk has a certain quality; if every three hours, it has a different quality, whereas when it becomes a question of six hours the milk is quite worthless.

That brings me to another matter, which is of equally great importance. However strongly we may recommend that the best method of feeding infants is by their mothers, we should be extremely careful to make it perfectly clear that we mean mothers who are able to provide a good milk for their infants. It is unfortunate that advice is frequently given which is of such a general character that it can be readily translated into: 'Let the mother nurse her baby at all costs, no matter what kind of milk she is providing.' I can tell you that some of the worst cases of malnutrition we have had to deal with in this hospital have been cases entirely breast-fed from the time of birth to the time when they were brought to the hospital. It is important to remember that, because if you advise mothers to nurse their infants in such conditions, it does not impress the mothers, and thus you lose the opportunity of being helpful, because you have given advice which, in those circumstances, is not good advice. And there are many other conditions which make it inadvisable for a mother to nurse her infant. The infant may be of such a type that the milk of the mother, although answering to a fairly normal standard, is absolutely unsuited to the infant. In such a case it must be weaned at once.

If the absence of maternal nursing is one of the great causes of infantile malnutrition, it finds a very good second in the methods of substitute feeding, which prevail throughout this country. Many have endeavoured to solve this problem, and it is a serious and difficult problem to be solved; but there is one principle which it is absolutely essential to adopt. It is very obvious, but so often neglected, that I make no apology for bringing it before your notice. The food that is recommended as a substitute for mother's milk must be a food, and must compare with mother's milk. Do not be misled by the common cry that 'no artificial food can compare with mother's milk.' The duty of everybody recommending a food for young infants is to recommend a food which does compare with mother's milk, and if you do not recommend that, then you are not recommending a food at all.

But, apart from the inadequate methods of substitute feeding, we have to deal with the poisons that are put in tins and advertised throughout the country as foods for infants, and it is perhaps worth while explaining to you something in regard to the origin of these foods. The attitude of the patent food manufacturer in regard to this question is very simple. He says: 'What is the cheapest thing that can possibly be put inside a tin?' Well, one of the cheapest things is starch. Starch in itself is a rather indigestible material, but by chemical action you can convert it into a coarse form of sugar, which is soluble. So he soon discovers the cheapest (and nastiest) 'food' imaginable. It does not answer any

of the requirements of a food; it has none of the properties which a food for infants should have, but it has one great quality, which such a patent food manufacturer welcomes: it is extremely cheap.

In regard to many of the patent foods on the market, I may explain that the tins and labels cost more than the stuff inside. Yet many of these foods are marketed at high prices, and thousands of people are deluded by the advertisements into buying them. The effects on the country are, of course, deplorable, because everybody who is not technically acquainted with the subject is misled to some extent by them. It is imperative that, before we can make any serious improvement in the conditions of infant life, it should be made a penal offence for any manufacturer to put forward as a food for infants anything which does not come up to certain requirements, and does not possess the essential qualities of a food to be given to an infant.

I am afraid that my lecture to-day has been a somewhat dull and dismal one, being almost entirely confined to death and disease, but I have taken you over this ground because it is so important that we should cultivate a sense of proportion, and that we should differentiate between the factors which are serious, and those which are comparatively trivial.

In my next lecture I shall deal with mother's milk. It is one of the most remarkable fluids it has ever fallen to my lot to study, and I shall endeavour to impress upon you its character and properties, not as they exist by themselves, but in their relation to the structure and development of the human infant.

LECTURE II.

MOTHER'S MILK.

MOTHER'S milk is a bluish-white fluid secreted within a few days of the birth of the infant, and lasting, in normal circumstances, for a period of about nine months. Its composition and qualities are peculiar to itself, and except for the milks of some animals, which, however, differ materially from it in composition, there are no bodies at all resembling it. I write on the board a table showing its constituent elements and their relative proportions:

	Per Cent.
Fat	4·00
Lactose	7·00
Proteins and nitrogenous matter ...	2·00
Mineral salts	0·25
Water	86·75

Its specific gravity as compared with water is 1030. The physical characters of milk are remarkable. The proteins are partly in solution and partly in what is known to chemists by the rather unsatisfactory term 'pseudo-solution.' Another very curious feature, none the less curious because familiar to you all, is that when milk is stored in a vessel the

fat proceeds to separate itself from the other constituents, and rises to the top as 'cream.' Some of the proteins and all the salts are dissolved; some of the proteins are suspended in the solution rather than dissolved, whilst the fat exists in milk quite separately in the form of discrete globules. There is a profound meaning in this remarkable combination of qualities, for it would seem that Nature has been at great pains to solve an otherwise insoluble problem.

As soon as its mother's milk reaches the stomach of the infant, the greater part of the protein is immediately precipitated in the form of 'curd.' Now, fat is the most powerful inhibitor of the secretion of the gastric juices known to us, and were the fat and the protein intimately mixed together, indigestion of a severe character would almost invariably occur.

The separation of these two elements thus plays an extremely important part in the digestive economy. The protein is precipitated on to the mucous membrane of the stomach, while the fat, which is not dealt with by the stomach at all, floats on the surface, and speedily passes into the first part of the small intestine—the duodenum.

One other characteristic of mother's milk is so important that I must not forget to draw your attention to it. Milk is a *raw* fluid. *Here* I have a specimen of human milk. I will place a small quantity in these two tubes, and add a few grammes of water to each. The tube (A) I place here. The tube (B) I take, and heat the milk over the Bunsen burner till it nearly boils. To both specimens I now

add 1 c.c. of ortho-methyl-amino-phenol sulphate, and a drop of hydrogen peroxide solution. You see what has happened.

(B)—the boiled specimen—is quite unchanged in appearance, while (A)—the raw specimen—has become of a deep brick-red colour.

I have performed this little experiment because I think it will impress upon you the importance, in all matters appertaining to infant-feeding, of adhering to *natural conditions*. Mother's milk possesses certain vital characteristic properties, which are intimately related to its function as a food for the young infant; and we have only to raise the temperature to 170° F. to destroy those very properties which are characteristic of it.

Let me now ask your attention to some of the details connected with its precise constitution, and the relative proportion of its constituents.

In the first place, we note the large amount of *water*. And this at once reminds us of a most important quality in the food of the young infant; it must be *dilute*. Water is required for all the tissues; without it those elaborate combinations necessary to the creation of structure and the elimination of waste products, cannot be effected. To the active chemical and physiological processes characteristic of the infant water in large amount is essential.

I show you two tubes of exactly the same capacity. In the one is the amount of water in 100 grammes of milk—approximately 87 grammes. In the other is the amount of solids—approximately 13 grammes. These two columns, the one of water, the other of

solids, will serve to impress upon you the relative proportion of the one to the other.

The *proteins* in milk next call for our attention. The amount present in human milk is much less than in cow's milk. That, however, is not by any means the most important difference between the protein material of human milk and that of cow's milk. The characteristic feature of mother's milk is the *quality* of the proteins: lactalbumin (the chief of the whey-proteins) is present in large proportion, whilst caseinogen (the 'curd'-forming protein) is only present in small amount. The 2 per cent. of nitrogenous material is present in the following proportions:

	Per Cent.
Whey-proteins	1·00
Caseinogen	0·40
Nitrogenous extractives	0·60

Contrast this with the 4 per cent. of nitrogenous material in cow's milk, made up as follows:

	Per Cent.
Caseinogen	2·50
Whey-proteins	1·00
Nitrogenous extractives	0·50

You see that we are here dealing with a question of the greatest import; for it is this question of the relative proportion of the 'curd' in milk which is one of the great difficulties in regard to the feeding of the young infant. Indeed, I may explain that in human milk of indifferent or bad quality we have frequently the same difficulty to face. One of the

commonest features of pathological lactation is the increase in the curd-forming element.

Into this glass dish (A) I place a small quantity of human milk. Into a second dish (B) I place a similar quantity of cow's milk. To both I add a few drops of acetic acid. You see the very different way in which these milks have reacted. In (A) there is a delicate powdery curd, which it takes a moment or two to recognize, it is so finely divided and so evenly distributed. In (B) is now a thick mass, so dense that, on tilting the dish, the mass scarcely moves.

Let me now take rennin—the ferment always present in the stomach of the infant. Tube (A) contains human milk; tube (B) cow's milk. I add to each a small quantity of rennin, and warm both tubes over the Bunsen till they are slightly over 100° F. You see the milk in (B) is already curdled, and the mass falls heavily and lumpily into the dish into which I pour it.

In (A) the fluid is quite clear, but you can see the delicate granules, rather than curd, lying at the bottom of the dish. I will show you one further experiment before proceeding. In the laboratory downstairs I took this dish, and placed in it a very thin layer of milk, just covering the bottom. I tilted it to the right, so that all the milk collected in the right half; then I added a drop of acetic acid. The curd was precipitated, and very gradually I brought the dish to the level, and finally tilted it to the left, so that the supernatant fluid ran off, and only the curd remained—on the right side of the dish. It was then dried in the water-oven. You will notice the

curious shapes the casein assumes, almost as if it were crystalline in structure, and you will remember what I said about its being in 'pseudo-solution.'

The *protein* I have demonstrated by these experiments is the actual structure material of the tissues. Every cell is laid down in protein. It is the foundation material, and is an essential element of every tissue in the human body, however simple or however complex.

We have now to consider the milk-sugar, or *lactose*. It is a carbohydrate peculiar to milk, having nothing in common with any other form of sugar. It is present in high proportion, being practically one-half of the total solids of human milk; and—please note this—it is the only form of carbohydrate found in milk. One important distinction between cane-sugar and milk-sugar needs to be mentioned, as it shows how different these bodies are. Cane-sugar, in the presence of yeast, ferments into alcohol. Yeast has no action on lactose. Lactose has chemical reactions of its own of the utmost importance to the infant. By means of the lactic acid bacillus, lactose is converted into lactic acid, which is a normal constituent of the gastric juices of the young infant. Upon the presence of lactic acid the health and life of the infant depend. By its means the acidity of the small intestine is maintained, and thus the processes of normal intestinal digestion are encouraged. When the infant is deprived of lactose, the supply of lactic acid fails, and organisms proper to the large intestine find their way into the small intestine, with lamentable results. You may find in the wards upstairs certain babies

whose milk tubes have been taken out of the ice-boxes and placed near the fire. Our object in these cases is to 'turn' the milk, so that there may be an increased amount of lactic acid. For those infants are suffering from the deprivation of lactose, among other things, and we want to restore the normal acidity of the intestine as quickly as we can. Until we succeed in that, we know that the infant cannot thrive, whatever food we give it.

The fat in milk is also present in high proportion —4 per cent. One of its great functions is the maintenance of animal heat. It is very deficient in oxygen, but rich in those oxidizable elements, carbon and hydrogen. The fats present in human milk are chiefly olein, palmitin, and stearin, and I will place their formulæ upon the board:

Olein	...	...	$C_3H_5(C_{17}H_{33}CO.O)_3$
Palmitin	...	...	$C_3H_5(C_{17}H_{31}CO.O)_3$
Stearin	...	...	$C_3H_5(C_{17}H_{35}CO.O)_3$

You see from these formulæ the enormous proportion of carbon and hydrogen to be oxidized, but you must not imagine that the oxidization is a simple process. The oxidization is only accomplished by an elaborate series of chemical processes in the tissues. These processes are of the greatest importance in regard to structure, for upon the perfection of the combinations and the proper elaboration of the processes depends the structure of the more elaborate tissues. For while protein establishes the development of structure, fat is the element essential to the elaboration of structure characteristic of bone, brain, and

muscle. Lecithin, for instance, is one of the most important constituents of the brain and the nervous system, and the stearin of human milk is the precursor of lecithin.

Absence of a proper amount of fat is the chief cause of rickets. I have seldom seen a case of rickets where the food has contained a normal amount of fat. If, in addition to the deficiency of fat, there is also deficiency of protein, then the result is the most severe and the most incurable cases of rickets.

The mineral salts of milk consist chiefly of calcium phosphate. The calcium enters into combination with the protein at the time the 'curd' is precipitated. Had I removed the calcium salts from the milk prior to those experiments I performed with acetic acid and rennin, then no curd would have been precipitated. The perfect combination of the protein material with the calcium 'fixes' it, so that it is conveyed to the tissues in proper proportion and in suitable form, and thus the normal development of bone is provided for. I may remind you that one of the common troubles of pregnancy is toothache and dental caries, for the embryo is drawing upon the mother for the calcium it requires to make bone.

In this brief summary I have drawn your attention to the constituent elements of milk, and have sought to show you how each element plays its part in making mother's milk what it is.

Mother's milk of good quality is the *perfect food*. This one fluid contains all the materials required for growth and development in a form eminently adapted to the structural requirements of the infant,

and to the peculiar characteristics of its digestive organs.

The function of mother's milk is all the more remarkable when we think of the infant as contrasted with the child or the adult. A baby weighs about eight pounds at birth; at five months it will weigh, under normal conditions, sixteen pounds; at twelve months it will weigh twenty-four pounds. So you see that sixteen pounds of human structure have to be actually created by the infant out of the food supplied. This is even more remarkable when we consider the relation between the work done and the worker. The larger and more powerful the machine, the more work we expect it to do; but the infant manufactures an amount of material structure, in the course of twelve months, which is twice its own weight at birth.

I think these considerations will impress upon you the physiological value of the fluid I have been speaking of, and its extraordinary adaptation to the requirements of the human infant.

Now I come to a most important practical aspect of my subject—the regimen of maternal nursing. The whole object of this regimen is to enable the nursing mother to provide a milk of efficient quality for a sufficient period.

For some little time after the birth of her baby it is necessary that the mother should rest. Anything in the nature of work or active exercise should be forbidden for a period of at least six weeks. After that, moderate exercise is beneficial. Walking exercise is one of the best forms. Let me impress upon you

two points: (1) It should be regular. (2) It should be moderate—enough to induce a gentle fatigue, but no more.

A reasonable amount of moderate exercise is of great importance to the nursing mother. She will not be able to maintain efficient breast-nursing, as a rule, if this is neglected. And as this is very little understood or acted upon, I draw your attention to it at the outset.

The food should be good and simple. It is well to caution you against the very common tendency to overfeed the mother. I frequently find that mothers are induced to consume inordinate amounts of food, under the impression that it is their duty to do so in order to maintain the quality of the milk. This is a very fallacious idea. The result in practice is that the mother suffers from indigestion; and I have never yet known mother's milk improved by maternal indigestion. There is another danger against which I must warn you, and that is against preserved foods, preservatives in foods, potted meats, *entrées* in tins, oxen in tea-cups, and all such things. For the expectant or the nursing mother they are altogether pernicious. In caring for the nursing mother, have nothing to do with preserved or tinned food of any kind. Let her have good food—bread, milk, eggs, butter, meat, fish—all the splendid foods that Nature has provided; let these be your model for her diet.

As a general rule, I would recommend that no stimulants be given. A glass of claret, or a little champagne and soda, may not be harmful, and may be appreciated by the patient, but all stimulants tend

to produce instability of the nervous system. Stout I would forbid as distinctly harmful, and I hope you will do what you can to put down the old wives' nonsense about Quacklet's Oatmeal Stout, and its beneficent effects on the nutrition of the infant.

One thing the mother does require, and that is a plentiful supply of water. It is a very simple requirement, and for that reason apt to be neglected.

I would also caution you very definitely against administering large quantities of milk. In moderate quantities, such as the mother cares about (and rather less if anything), milk is beneficial, but there is a great tendency towards the consumption of inordinate quantities, with the results of indigestion and other troubles. One pint of milk a day is ample. Milk is *not* a good milk-producer, and does not compare with beef-steak in this respect.

I will give you a little formula of my own which I often find useful: Four ounces of milk, 4 ounces of water, and a tablespoonful of cream. A little sugar may be added if the patient likes it. When you are ordering milk, remember that it is always best given alone. You should never give it in combination with meat.

My last rule is of the greatest importance. The nursing mother must avoid excitement and emotional distractions of all kinds; she *must* be quiet and placid. I have analyzed a large number of human milks, and I can tell you that some of the most serious perversions have been those caused by nervous disturbance of the mother.

This is not confined to the human race. Every

practical farmer will tell you that if you want to spoil the yield of milk from your cows, and spoil its quality, you have only to let a dog loose in the stables, to place the cows in strange quarters, or exhibit them at agricultural shows. In conclusion, I will now demonstrate, by means of the Epidiascope, the character of some of the structures with which mother's milk is concerned.

The first is a section showing the mucous membrane of the stomach. You see the rows of tubular glands lined with epithelium, so that the surface of the membrane is deeply pitted by the orifices of these glands. Upon this membrane falls the precipitated casein. The fat, as I explained earlier in my lecture, passes on to the duodenum, and in this section which I now throw on to the screen, you see the large projecting club-shaped masses, which are termed *villi*. These absorb the fat, and, in this next section, I show you the villi with their blood-vessels injected. You see their enormous blood-supply, which enables them to deal with the intake of food.

Now, let me illustrate the architecture of Nature by throwing upon the screen a beautiful specimen. It is a complete section through the hand of an embryonic infant, at about the twentieth week of gestation. I draw your attention to the phalanges. You see the layers of bone-forming cells all in the most perfect order. You can trace the line of demarcation between bone and cartilage, and you see everywhere the cardinal note of normal structure — the perfect order of the processes of development.

Here I show you a section through the finger of an embryonic infant. It represents a rather later stage of development than the former specimen, and you see in the centre of the phalanx the definite bone formation, while each end of the phalanx is still cartilaginous.

And at the time Nature is creating these, she is preparing for the supply of the milk which is necessary for their later development.

But if mother's milk is not available, however much we may desire it, what shall we do then?

That will be the subject of my next lecture.

LECTURE III.

SUBSTITUTE FEEDING.

In my last lecture we discussed the character and properties of mother's milk, and this afternoon we have to deal with the question of providing a substitute when the natural food is not available.

Now, there are, as you are aware, many methods advocated, and it is necessary for me to define what we mean in this hospital by the term 'substitute feeding' as opposed to 'artificial feeding.'

By the term 'artificial feeding' we mean methods of feeding in which the principles adopted are opposed to the natural methods as illustrated by mother's milk. For instance, one of the important characteristics of the infant's natural food is that it is a raw fluid. If you are feeding an infant by means of a cooked food, then, of course, that method is artificial. In general, therefore, we regard the term *artificial feeding* as synonymous with *improper feeding*.

There are, practically speaking, only two methods of substitute feeding: (1) a wet-nurse; (2) cow's milk, modified under natural conditions to meet the individual requirements of the infant.

The wet-nurse is a rather difficult article to obtain,

and is frequently far from satisfactory when she is obtained. The use of a wet-nurse to-day is a haphazard and empirical method compared with what can be done by the scientific use of cow's milk. This being the case, I shall at once proceed to deal with substitute feeding by means of cow's milk.

The principles and the practice which I shall explain to you this afternoon we owe to the genius of Dr. Thomas Morgan Rotch, Professor of the Diseases of Children in Harvard University, and one of the Consulting Physicians to this hospital. The lasting value of his work in connexion with infant feeding lies in the fact that he did not merely introduce great improvements upon the methods current at the time he began his work; he did much more than this, for he brushed aside the empiricism that surrounded the subject, and for the first time in the history of medicine placed infant feeding upon the sure basis of scientific method.

The first thing necessary for substitute feeding is pure cow's milk. This is so entirely different from the article generally sold in this country as 'milk,' that I will describe to you the methods which are pursued at the farm supplying this hospital. The farm at Sudbury, in Middlesex, was designed by me in conjunction with Mr. G. Titus Barham, in 1902. From the photographs that I now pass round you will obtain a general idea of the arrangements at the farm. The first is simply a photograph showing the buildings from the outside.

The cows are very carefully tended. They are kept in a very clean cowshed, which is well lighted

and properly ventilated. The floor is of solid concrete, and no drains run underneath it. In every way it is constructed so as to obtain perfect sanitation. The cows are regularly washed and groomed. The udders are washed before milking, and the milkers wash their hands and wear sterilized overalls. A sheet is put over the cows at the time of milking in order to prevent hairs falling into the milk. Every vessel used in the handling of the milk is sterilized, and all the vessels used for the collection of the milk are sterilized before each milking. The milking pail used is a special one, having a narrow opening at the top, and is provided with a lid which protects the milk from the time that the milking is completed. A separate pail is used for each cow.

A very important point indeed, which has hitherto received very little attention in this country, is the diet of the cows. You all know the importance that is attached to the diet of the nursing mother, so as to avoid injurious elements getting into the milk. It is precisely the same in the case of the cow, and many of the materials commonly used in this country for the purpose of feeding the cows are directly injurious to infants. Oil-cake, for instance, should never be used in any circumstances to feed cows producing milk for infants. Many other articles must be excluded, whilst others do not need to be altogether excluded, but require careful adjustment. Mangolds in a very moderate proportion are permissible when properly blended with maize-meal, pea-meal, bran, and other ingredients. These are good foods if they are given in proper proportion, but given out of proportion, or

in excess, they at once produce a deleterious influence upon the milk.

Directly the cow is milked, the covered pail is transferred, by means of an automatic railway, to the refrigerating-room, and here the most important step in regard to the milk is taken. Milk was naturally intended to be transferred directly from the mother to the offspring. It was never intended by Nature to be handled or stored in any manner whatsoever, and, consequently, when you adopt such measures it is necessary to take steps to provide against the dangers which that course otherwise entails. In the purest milk there are always germs, and let me impress upon you again that germs are beneficial as well as injurious. No milk is ever free from germs. No baby's mouth exists that has not myriads of organisms in it every hour of the day. No healthy stomach exists without myriads of bacteria in it. The *development* of bacteria in milk after milking is the danger that we have to deal with. At normal temperatures this development of bacteria is prodigious, and the consequences are very serious indeed, for as a result of this development two things happen : (1) an enormous multiplication of the bacteria ; (2) the production of toxins as a result of the vital processes of the living and multiplying bacteria. In addition to these changes the fats, lactose, and proteins are split up by the bacteria, so that in a very few hours you get a fluid altogether different from natural milk. All this we have to prevent.

At a temperature of 40° F. bacteria are not killed,

but they altogether cease to multiply. They become quiescent, do not develop, and consequently do not act in any way upon milk. It is necessary, therefore, for us to get the milk, within the shortest possible time, down to a temperature of 40° F. This means that we have to reduce the milk to a temperature of about 8° above freezing within a very few minutes after milking. When we first made the attempt we did not find it a very easy task. We experimented with large tanks of water, through which a large quantity of brine in pipes circulated at a temperature of 32° F. The milk was bottled and the bottles were placed in this water, and the refrigerating machinery pumping the brine was working all the time. What did we find? We found a very rapid fall in the temperature of the milk—and the water, I may say, was at a temperature of 36° when the bottles were put in—but we found also a very rapid rise in the temperature of the water. There, in fact, ensued an approximation of the temperature of the milk and the temperature of the water to each other, with the result that we obtained in the course of two hours a large bulk of milk and a large bulk of water at 60° F. Of course, that was much lower than 100° F. (the temperature at which milk comes from the cow), but it was still 20° over the required temperature, and it took another two hours' work on the part of the refrigerating machinery to reduce the milk to 40° F. You see, then, that in our first attempts it took us four hours to get the milk down to a temperature of 40° F. How were we to overcome this difficulty? It was overcome by throwing

the whole power of the refrigerating machinery at one moment on a very small quantity of milk. Instead of dealing with the whole bulk of milk at one time, the power of the refrigerating machinery is thrown in turn upon each pail of milk as it comes from the cowshed. This photograph shows you the very simple arrangement by which this is done. Each pail of milk goes to the refrigerating room, and inside the dome, which you see in the photograph, the brine is circulating at a temperature of 32° F. The milk falls in a thin film over the dome, and then passes out through the channel at the bottom (Fig. 1). In the few seconds it takes in passing over the dome it is reduced from 100° F. to 40° F. The milk thus refrigerated is bottled immediately, and then taken to the cold-storage room, where it is maintained at a temperature of 40°. The maintenance of the milk at a temperature of 40° is, you will understand, easy when once the bulk of milk is reduced to that temperature; and you will realize how readily that is done when you remember that the whole of the time the milk is coming from the cowshed the refrigerating process is going on. Each pail of milk is dealt with as it arrives, and as soon as the milking is finished the refrigerating is finished. They both start and end together. *Here* is a photograph of the refrigerating apparatus itself, and *here* is a photograph of the machinery-room. Since these were taken the machinery has been enlarged, but there is no material alteration except its increased size.

In this way, then, by attention to the cows, by

FIG. 1.—THE MILK REFRIGERATOR.

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attention to their diet, and by attention to the all-important question of the refrigeration of the milk, we are able to obtain the pure cow's milk essential to the success of substitute feeding. But while pure milk is the first essential, without which nothing can be done, we are still a long way off the provision of a milk suited to the needs of infant feeding. And I will now ask your attention to the methods by which the preparation of the substitute food is carried out.

Looking for a moment at the composition of cow's milk, and comparing it with mother's milk, we at once see that no method of simply diluting cow's milk can meet the necessities of the case. For instance, the percentage of fat in both is 4 per cent. We need to reduce the caseinogen in cow's milk, but not the fat. But by diluting milk to reduce the caseinogen you at once reduce the fat. When we come to the lactose we find we are even worse off, because, while the milk-sugar in mother's milk is about 7 per cent., in cow's milk it is only about 4·50, so that we ought to add lactose instead of diminishing the already insufficient amount. When we come to the proteins the troubles are even greater. In my last lecture I explained that the proteins in mother's milk were characterized by the extreme delicacy of the curd-forming material, and that the proportion of caseinogen to the whey proteins is as half to one, or even less than that. In cow's milk the proportion of caseinogen is much greater than that of the whey proteins. Thus, we have 1 per cent. of whey proteins in human milk, of caseinogen we have 0·40 per cent. In cow's milk the caseinogen is

2·50 per cent., whereas the whey proteins are only about 1 per cent., and rather less if anything. Obviously, any attempt to adjust these differences by dilution of the milk would be entirely inadequate.

In the milk laboratory (Fig. 2), the first thing we do is to separate the cow's milk, without the aid of chemicals or artificial methods, into its different constituents. I have told you that the proportion of the constituents varies, but you will also have realized that there is nothing in cow's milk which is not present in mother's milk, and nothing in mother's milk which is not present in cow's milk. I have here all the materials into which cow's milk is separated. The milk is first of all passed through a separator, which takes all the cream on one side and the fat-free milk on the other. When the cream has passed through the separator, the first thing we do is to find out exactly the amount of fat in that cream. According to the diet of the cows, or according to the condition of the cows at the time, the actual amount of fat varies, so we find out exactly how much fat is present in the cream. We then make a standardized cream, which is generally a 32 per cent. cream—*i.e.*, it contains 32 per cent. of fat. I show you the fat-free milk and the standardized cream. But we have still the question of the whey-proteins and caseinogen to deal with. Some fat-free milk is treated with rennin, and the curd is precipitated. This is filtered, and we have then whey containing all the whey-proteins, but none of the caseinogen. Now we prepare a solution of lime-water and a solution of lactose. I propose, now, to show you how

FIG. 2.—THE MILK LABORATORY.

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the infant's food is constructed, and you will see at once the simplicity and the exactitude of substitute feeding by laboratory methods. I must, however, explain one important point. The milk laboratory does not put forward any mixture as a 'food for infants.' All it does is to construct a food in exact accordance with the prescription of the physician in charge of the infant. As an illustration, I will write a prescription upon the board:

℞	Per Cent.	
Fat	3·00	Ten Feeds of 2 ounces, unheated.
Lactose ...	6·50	
Whey-proteins	0·75	
Caseinogen ...	0·25	
Alkalinity ...	5·00	

That is to be the composition of the food. As you see, the number of feeds must be indicated. In this case I have made each feed 2 ounces. Then we have the instruction 'unheated.' It must be remembered that this instruction is a laboratory instruction, and means that it is not to be pasteurized or sterilized. Before the food is given to the infant it is warmed in the usual manner.

I will now prepare the mixture before you, so that you will be able to see the actual method by which the mixtures are prepared.

Of the standardized cream, 2 ounces are required. To this I add $3\frac{1}{2}$ ounces of the lactose solution. Then we take the whey, of which $12\frac{3}{4}$ ounces are required. Two drachms of fat-free milk, 1 ounce of lime-water, 4 drachms of distilled water I add in turn, and now we have a mixture of 20 ounces, cor-

responding in precise composition to our prescription. In order to ensure that all the ingredients are thoroughly and equally blended, I carefully mix them by pouring the milk several times from one jug to another. All we have to do now is to arrange the separate feeds by putting 2 ounces in each tube.

All the infants in the hospital are fed on milk-mixtures, prepared according to the method I have just demonstrated to you, and in the ward-service room you will be able to see the tubes in the ice-boxes, labelled for each infant.

This, then, is the method of *substitute feeding*. You will see that all the essential principles are carefully observed, so that we may prepare a food meeting the requirements of the individual infant, and constructed on the plan of the natural food of the infant.

In order that you may realize the delicacy of adjustment which is possible by these methods, I show you six specimens of modified milk. They all differ in the amounts of caseinogen they contain. And I will pour a small quantity from each beaker into glass dishes.

No. 1 contains no caseinogen. No. 2 contains 0·25 per cent. No. 3 contains 0·50 per cent. No. 4 contains 0·75 per cent. No. 5 contains 1·00 per cent., and No. 6 contains 2·00 per cent.

To each I will add a few drops of acetic acid. You see the result. In No. 6 there is a heavy precipitated mass. There is a marked difference between this result and the curd in No. 5. In No. 4 the curd is distinctly finer than in No. 5, while in No. 3 the

curd very closely resembles the precipitate characteristic of human milk. You will remember the specimens of human milk precipitated by acetic acid and rennin that I showed you in my last lecture.

In No. 2 you see the curd is so delicate that it almost escapes observation, while in No. 1 there is no curd at all. You will have an opportunity of carefully comparing these reactions at the end of the lecture.

I have now very briefly explained the processes involved in the modification of milk to meet the needs of individual infants; that is all I propose to say this afternoon. To enter more fully into the subject would mean a discussion of the whole art and science of infant feeding. We shall no doubt be delivering some more lectures on various aspects of this subject. In this course, Dr. Kelynack and I have endeavoured to lay the first principles of the subject before you, so that in further lectures we may be in a position to discuss the conditions in more detail.

LECTURE IV.

INFANTILE MALNUTRITION.

INFANTILE malnutrition is the most serious of all conditions prejudicially affecting this country at the present time. It is responsible for a multitude of disorders and diseases affecting all classes of society, and by no means confined to the poorer classes. In explaining the various phases of the subject, I am particularly anxious to impress upon you the importance of diagnosis and careful observation. I shall do you much more service if I can elucidate the character of malnutrition and its distinguishing features, than by giving you a few fragments of more or less useful advice in regard to the treatment of a baby that is not thriving. The diagnosis of the precise conditions in a baby suffering from malnutrition is of the first importance, because without the essential of accurate diagnosis it is impossible to treat the baby with any degree of success.

What do we mean by the term *infantile malnutrition?* A great deal is involved in that term, at any rate as we use it in this hospital. In the first place, it implies that the baby was *born healthy*. It is necessary for me to draw your special attention to

this point, because it is one that is very inadequately appreciated, and a great deal of confusion is caused by including in one category widely differing conditions.

Why do I lay down as the first essential in our meaning of infantile malnutrition that the baby is healthy at birth? The reason is a very simple one. Many people suffer from malnutrition. The victim of typhoid fever, for instance, wastes; a baby the subject of constitutional disease is not likely to thrive. When, therefore, we say that an infant is suffering from malnutrition, we do not mean secondary malnutrition, but primary malnutrition.

By primary malnutrition we mean that the ill health of the infant is directly related to the character of the food it has received. If the term implies a baby born healthy at birth, it also implies the *exclusion* of a variety of conditions. Specific constitutional disease is forthwith excluded. Defective development at birth is excluded because obviously if a baby is born in a condition of faulty and imperfect development, so that the digestive structures are incapable of performing normal functions, it is incapable of digesting food. We speak of such an infant under different terminology, and, therefore, when we speak of malnutrition we exclude these conditions. If I labour this point somewhat, it is because of its cardinal importance with regard to both prognosis and diagnosis. If a baby's condition at birth is hopeless, so that it is only capable of living a few weeks at most, we must recognize this at once, for it is doubly distressing to the mother to

learn that her baby cannot live, after she has been led to believe otherwise.

There is one set of cases extremely liable to be confused with malnutrition. They belong to a wide group, but I will give you the generic term we use in this hospital to cover them all—*asthenia congenitalis:* want of strength at birth. Asthenia congenitalis covers (1) premature infants, and (2) immature infants —*i.e.*, infants born at the end of the full period of gestation, but still not perfectly made, born with some defect which is sometimes easily detected, at other times by no means so obvious.

The most important point in regard to the differentiation between malnutrition and asthenia congenitalis is the *length of the infant.* A normal infant at birth measures 21 inches in length. Babies, as you are aware, vary very much in regard to the actual weight at birth, but their length is a singularly constant measurement. You may be quite sure that no baby that is fully developed and mature measures less than 20 inches. This measurement is taken not from the vertex, but from the occipital foramen. The tape is passed along the back of the head, along the middle line of the body between the legs, held together, to the heels. That measurement, in the case of a normal infant, is 21 inches. You will appreciate the importance of the measurement when I tell you that it is only in exceptional circumstances that we admit an infant measuring less than 20 inches, while infants measuring less than 19 inches are practically never admitted. It is sufficient for us to take a measurement of, let us say, 18 inches, to reject

the baby on the ground that it is in a condition of asthenia congenitalis. It is born wrong; it is not in a condition of malnutrition; and, therefore, does not come within the scope of our work in this hospital.

There is no rule without exceptions, and I have selected the following cases which illustrate some of these: Marjorie B——, No. 699, was admitted to the hospital, aged four weeks; weight, 5 pounds 15 ounces; length, 19 inches. She was born in the York Road Lying-In Hospital; induced labour, two weeks before full time. You see how the history and the measurement go together. I impress upon you that most babies of that length would not survive. In this case there were some points in its favour. (1) The labour was induced; (2) the baby was cared for in a hospital from birth; (3) she was brought to us at a very early age. At first there was little improvement, but now the baby is steadily gaining in weight. She is still in the hospital.

Here is another baby, Ada E——, No. 807, six weeks of age; weight, 5 pounds 15 ounces; length, 19½ inches. She is one of twins, and the prognosis is, therefore, somewhat more favourable. When multiple pregnancy is in consideration, a length of 19½ inches is very considerably better than if the baby were not born a twin.

Here is a baby aged three weeks; weight, 6 pounds 5 ounces; length, 20½ inches—a suspicious length. The mother has had two previous infants, the first died at seven weeks of age, the second at eleven days.

In combination with that of the third infant, the history is strongly suggestive of the fact that she gives birth to infants characterized by some degree of asthenia congenitalis. Do not conclude that all conditions of asthenia congenitalis are inconsistent with healthy development. It is a question of degree. If the degree of defect is slight, we may hope to neutralize it, but if it is at all severe it is generally quite hopeless.

Let me now draw your attention to two phases of malnutrition. The first is one in which the baby has received a pure food, but it is deficient in quantity and in quality—that is to say, the chief defect of its food supply has been the *absence* of those materials requisite for its development. The other phase is one where the baby has received improper food—maybe a very large amount of food—but some of the materials requisite for its structure and development have not been present, while other materials, which ought not to be there at all, have been present in large amounts.

To illustrate these phases, I will quote two typical cases from my 'Clinical Studies in the Treatment of the Nutritional Disorders of Infancy':

CASE XII.—D. H., female infant, admitted March 29, 1904; aged six months; weight, 6 pounds 11 ounces. The infant weighed 7 pounds 8 ounces at birth. It was entirely breast-fed for the first four months, and was then given milk and barley-water. The infant suffered from a bad cough. The case was sent from Guy's Hospital.

In this case you see there is an almost complete

absence of the horrible concoctions sometimes given to infants. For four months it had nothing but its mother's milk, and then cow's milk with barley-water. On admission it received a food according to the following prescription :

℞	Per Cent.	
Fat	1·00	Nine Feeds of 5 ounces. Interval, two and a half hours.
Lactose ...	5·00	
Whey-proteins	0·50	
Caseinogen ...	0·10	
Alkalinity ...	5·00	

Gradual adjustments were made by some eight prescriptions, the last being :

℞	Per Cent.	
Fat	3·00	Nine Feeds of 6 ounces. Interval, two and a half hours.
Lactose ...	6·50	
Whey-proteins	0·75	
Caseinogen ...	0·40	
Alkalinity ...	5·00	

The infant left the hospital on May 26, having gained 3 pounds 11 ounces in a little under two months. The critical condition of this infant on admission may be realized to some extent from the fact that it was not able to suck until it had been in the hospital for four weeks.

The next illustrates the other phase :

CASE XX.—E. C., male infant, admitted February 10, 1905 ; age three and a half months ; weight, 8 pounds 6 ounces.

It was a 'fine baby at birth ; quite plump.' Breast-fed for the first fortnight. The infant suffered from

'wind,' and the doctor found there was no fat in the milk. Then given Nestlé's Food, then cow's milk and water, then 'humanized' milk; then taken to another doctor, who ordered Mellin's Food. No improvement, and the infant was taken to a 'homœopathic' doctor, who ordered Benger's Food. Has been wasting continuously. Intestinal dejections hard, brown. Inguinal hernia.

The weight chart in this case brings out one of the distinguishing features of such a case. The infant loses 2 ounces, then gains 6 ounces, then loses 4 ounces, and so on. In such a condition the tissues must be deprived of the wrong and unhealthy material before any satisfactory progress can be made. It was six weeks before a steady gain began, and then the infant gained 2 pounds in less than a month. Remember the long period before real progress was achieved, because it will serve to impress upon you the meaning and the effects of disordered nutrition in the young infant.

I give the first and the last prescriptions for this infant, as recorded in the diet chart (Fig. 3):

℞	Per Cent.	
Fat	1·50	Ten Feeds of 2½ ounces. Interval, two hours.
Lactose ...	5·50	
Whey-proteins	0·50	
Caseinogen ...	0·25	
Alkalinity ...	5·00	

℞	Per Cent.	
Fat	2·00	Nine Feeds of 7 ounces. Interval, three hours.
Lactose ...	6·50	
Proteins ...	1·50	
Alkalinity ...	5·00	

THE INFANTS HOSPITAL.

*Register No.*_____ *Name* _____

*Born*_____ *Admitted*_____ *Vaccinated*_____ *Discharged*_____

Date.	Age.	Weight.		Fat.	Lactose.	Albuminoids.		Alk.	Number.	Amount.	Interval.	Remarks.
		lbs.	ozs.									

FIG. 3.—THE DIET CHART. (*Much reduced.*)

In regard to the signs of malnutrition, we must not forget that it is extremely insidious in its onset. The baby is noticed to be not thriving, unhappy, fretful, is pallid, looks anæmic; its face is wrinkled, its skin harsh and dry. Very often you will notice a condition of the head if the malnutrition has lasted for any considerable time, which is quite characteristic —a mass of dry scales on the head, very tenacious, and highly irritant to the baby. One sign is always present—the baby is unhappy. Some time ago, when we were at Hampstead, I was going round the hospital with a doctor, and I turned to the Sister, saying, 'That baby is very much better'; and the Sister replied, 'Yes, she is.' I had not examined the baby, and the doctor standing by was rather astonished at my remark. I think he was a little shocked that I had not put a stethoscope on its chest or had not felt its pulse. He said: 'How do you *know* that that baby is so very much better?' I replied: 'I have seen that baby for the last month; it has always looked very unhappy, though its expression has been becoming much less strained, but I have never seen it smile until to-day.' You may be quite sure that, when a baby who has been ill begins to smile, it is a most valuable indication of progress. When I see that, I expect to see a gain recorded on the weight-chart.

There are many special signs and symptoms connected with this nutritional disorder. Vomiting is a very frequent sign. On the other hand, you may find a severe degree of malnutrition without any

vomiting whatever. The character of the intestinal dejections is of the utmost importance.

When you have to deal with a baby suffering from malnutrition, put out of your mind at once any idea of giving that baby what is known as a 'good food.'

Let me give you a very common history as I hear it in consultation. The mother fed the baby for a short period, and then she became unable to do so, or the baby suffered so much that she was compelled to abandon the attempt. Some method of feeding the baby, such as with humanized or sterilized milk, was resorted to, with at first some apparent degree of success. Of late, however, the parents have been very far from satisfied, and it is obvious that the baby is ill. They are compelled to abandon the food they have been using, and resort to some of the more desperate measures, such as peptonized milk. The infant refuses to progress, and by this time the parents are very anxious and upset, and they decide to employ a wet-nurse.

So they proceed to one of the lying-in hospitals, and great pains are taken to secure a strong and healthy wet-nurse who may provide the food the infant so urgently requires. The wet-nurse is obtained and arrives. In the first twenty-four hours some considerable improvement is manifest; everybody is very pleased, and the household is happier than it has been for a month or two past. Suddenly the baby becomes very seriously ill, collapse of an urgent character occurs, and the poor baby is in desperate straits. Had I been seeking a wet-nurse in such circumstances, I should have been inclined

to ask for the most anæmic and miserable-looking specimen they had in the hospital. When a baby has been suffering from malnutrition for some time, when the whole of its digestive glands have been becoming more and more out of action, it is quite impossible for that baby to react to such an extent that, when it is provided with a food normal for a healthy infant, it can do anything with it but get seriously ill. The first thing to remember is the condition of the digestive tract of the infant, what it is capable of digesting, and that very delicate food will be a good food, because it will be the one suited to its requirements.

When I am treating an infant of such a kind, I pay no attention to the question of whether the food I am ordering is a rich or a poor food. What we have to consider is, firstly, the condition of the digestive glands, secondly, the relation of the food we have ordered to that condition, and, thirdly, to what degree we can adjust the constituents of the food to the changing conditions of the infant.

When malnutrition is continued for a long period, or the malnutrition, owing to the character of the food, is very severe, the condition occurs which is known as atrophy, or marasmus. In this hospital these terms are used solely to mean the results of malnutrition.

Marasmus is a word derived from the Greek, and means 'to waste'; and just as we use the word 'malnutrition' to imply primary malnutrition, and not secondary malnutrition, so we use the term 'marasmus' to express the result of long-continued

malnutrition. Atrophy, in the same way, means a loss of function. You cannot very well lose a function you have never possessed, and therefore a baby cannot be born in a condition of atrophy. A baby may be born in a condition in which the functions have never developed—that is quite a different class of case—but 'atrophy' implies that the function was present at birth, and has been lost in consequence of the adverse conditions to which the infant has been subjected. In my lecture on atrophy and marasmus I propose to discuss in more detail the treatment of these conditions.

LECTURE V.

ATROPHY AND MARASMUS.

Of the two terms which I have chosen for my lecture this afternoon, marasmus is probably the one most commonly used. It means very little, since, as I explained in my last lecture, it is only a Greek word meaning wasting. On the other hand, the term atrophy is a correct term, and therefore a very much better one, because it signifies the essential character of the disease. The more you study malnutrition, the more you will realize that its essential character is a loss of function. I impress upon you, therefore, that while marasmus is rather a poor term, atrophy is a very good one, because it conveys the meaning of the condition we have to deal with.

The appearance of an infant suffering from atrophy is very characteristic. As you are doubtless aware, one of the commonest remarks passed about an infant in an atrophic or marasmic condition is that it looks very old. It has the appearance of old age. Its cheeks are sunken, its features are withered and wizened, and generally it has the appearance of individuals in a condition of senile decay. In old age this is the natural sequence of events. The

vital activity of the cells of the digestive organs is gradually lessening until the processes become so feeble as to be incompatible with life. In the infant the atrophy is similar, both in its nature and in the appearances to which it gives rise. The cause is different. The sunken cheeks and the withered appearance are due to the subcutaneous fat disappearing, this being consumed in the processes of oxidization. That is the reason why the atrophic infant presents the appearance I have described; that is the reason the aged person is wrinkled and wasted.

The relationship between the food received and the digestive reactions in the young infant is extremely profound, and we see this relationship exemplified in the baby more than in any other individual, because it is the time above all of development. I invite your attention at the outset of our discussion on atrophy to some very important researches which Professor Pawlow, of St. Petersburg, carried out some time ago.

He showed that an almost exact proportionate relationship exists between the quantity of gastric juice secreted and the amount and character of the food taken. Most of his experiments were performed on dogs. For instance, a dog was fed with a diet of raw meat, and he found that for 100 grammes of meat, 26 c.c. of gastric juice was secreted; for 200 grammes, 40 c.c.; and for 400 grammes, 100 c.c. Pawlow concluded that since the food is made up of several constituents, and since different juices are poured out in the alimentary canal, it appears natural to suppose that each fluid, with accentuation of

certain of those properties, is obtained chiefly as the result of the particular kind of food. The influence and the precise quantity of the different gastric secretions is shown by the following table. A dog was first fed with bread, then with raw meat, then with milk, and the amount of gastric juice and its digestive power were noted in each case :

	Hourly Quantity of Juice.	Digestive Power.
Bread (200 grammes) ...	3·2 c.c.	8·0 mm.
Raw meat (200 grammes)	8·0 c.c.	5·37 mm.
Milk	9·2 c.c.	3·75 mm.

He had a tube of material capable of being digested, and according to the number of millimetres which were digested, he estimated the digestive power; so that with 200 grammes of bread you see there was an hourly secretion of 3·2 c.c. of gastric juice, and that gastric juice has a digestive power of 8 mm. With raw meat you have a much greater quantity of juice, with a lower digestive power. Thus, for bread the smallest quantity of juice is secreted, but this juice possesses the highest digestive power; for meat the next highest amount of juice, with a lower digestive power; while for milk we find the highest amount of juice secreted, with the lowest digestive power. If you consider the meaning of these facts, you see at once the explanation of atrophy occurring in the infant.

Assuming that an infant is improperly fed, it means that it is not receiving milk of a proper character, which is the only food that it should receive. And the point I wish to impress upon you is that depriva-

tion of food—with consequent starvation—is not the only injury. A more serious injury, directly affecting structure, is incurred. The digestive glands are not being exercised in the way they should be, and the development of these glands is irretrievably injured. You see from this table that a large amount of secretion is required to deal with milk; if the gastric cells are not stimulated—*i.e.*, are not being called upon to provide this secretion—they rapidly deteriorate and atrophy. All digestion is a response to stimulus: remove the stimulus, and you take away the exercise, and just as a muscle will atrophy if it is never used, so the whole digestive structure of the infant becomes inevitably and incurably enfeebled, if the absence of the healthy stimulus is allowed to continue.

Let me remind you of certain conditions which are necessary to produce the terrible appearance presented by an infant suffering from a severe degree of atrophy. First, it must be healthy and of good size at birth. In the second place, it must be fed with good food for some time (*e.g.*, breast milk of good quality)—for a period of, say, two months. And thirdly, it must be then subjected to severe deprivation of the good food, and the substitution for it of materials altogether unsuitable, and incapable of providing the necessary stimulus.

I draw your attention to these conditions, because we may have to deal with an infant weighing, for example, 7½ pounds, and presenting extreme signs of atrophy and wasting; whereas an infant weighing 6 pounds may present none of the signs. The latter infant was a very small baby at birth; it has not wasted, and consequently does not present the signs

FIG. 4.—ATROPHY.
A C., aged 7 months; weight, 6 pounds 12 ounces.
Page 55.

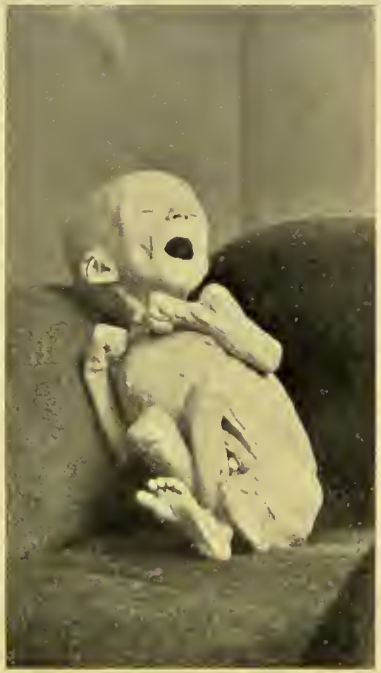

FIG. 5.—ATROPHY.
J. M., aged 7 months; weight, 7 pounds 10 ounces.
Page 55.

FIG. 8.—'FAT-RICKETS.'
I. L., aged 3 years; quite unable to walk.
Page 77.

of atrophy. I will now throw on the screen, by means of the Epidiascope, photographs of infants exhibiting the typical appearances of advanced atrophy (Figs. 4 and 5). You see at once that the infants are 'big' babies. Note the size of the hands and feet and the length of the trunk. But the soft tissues have almost disappeared; the cheeks are sunken; the skin hangs around the arms in loose folds, and the whole appearance reminds one of the pictures we have seen representing the results of an Indian famine. Here we have three views of the same infant. The deeply wrinkled face and the look of wan misery are characteristic; while the pronounced loss of subcutaneous tissue is best shown by the loosely hanging folds of skin in the gluteal region.

Having briefly summarized the means by which the atrophied infant is produced, I pass to the treatment of the condition.

In the first place, it is important above all things to keep the baby warm, and by warmth I do not mean hot-water bottles. They are very valuable in assisting to keep the infant warm, but there is only one healthy means of ensuring sufficient heat, and that is by keeping in the heat which the baby itself manufactures. Cold feet are a common symptom, and a very useful means of saving a baby from the loss of heat at the extremities is to wrap them in cotton-wool well up to the knees. Take a square foot of cotton-wool, completely envelop the foot and leg below the knee — covering this, if necessary, with jaconet. In some cases, when all methods have failed, this will succeed, because it provides the insulation which prevents the loss of heat occurring.

If loss of heat occurs, so that the feet are cold, the blood is chilled in the extremities, and, passing through the veins in the abdominal cavity, cools the tissues so that the digestive processes are under even greater disadvantages than they might otherwise be.

As a rule, there is a great perversion of the whole of the digestive processes, and therefore we generally begin with a dose of castor oil, if the general condition of the infant permits—that is to say, if the collapse is not too great. We frequently follow this by the administration, for a short period, of mercury in the form of grey powder or calomel. This is often necessary, because there is so much chemical decomposition taking place in the alimentary canal that it is very little use giving any kind of food until we have done something to rid the interior of the infant of these unhealthy and poisonous products. Very often the baby is in such a critical condition that more energetic treatment is required. Brandy, 5 minims to a teaspoonful of warm water, is a useful stimulant, but one of the most valuable is a subcutaneous administration of normal saline solution. It is well for me to remind you that the amount given should be small, certainly not more than 4 ounces; very often an injection of 2 ounces is quite sufficient, and it is much better to repeat the administration of that small amount several times than endeavour to give a large amount at one time.

One of the great difficulties in treating babies suffering from atrophy is the common experience that the baby 'does not take well'; that is to say, that after taking half an ounce or an ounce, it does

not want any more. Let me caution you against attempts to forcibly feed the infant by means of nasal feeding, stomach-tube, or any measures of that kind. In these cases we are not dealing with a case of diphtheria, where there is physical difficulty in swallowing; we are dealing with a case where the 'not taking well' is a valuable indication of specific inability to digest food. The digestive secretions are not there, and cannot be provided. The infant cannot deal with food. Appetite depends upon the secretion of the digestive juices, and the baby is protecting itself by refusing to take food which would only be subjected to chemical decomposition in its stomach and intestines, and therefore would poison it. We must wait patiently in the hope that the small amount of food which it can take will provide the stimulus it requires. Here, again, we see how necessary it is to remember the essential condition—atrophy of the function. In such conditions only the very gentlest stimuli can gain response; with greater stimuli, beyond the power of reception, food, so far from stimulating the functions, causes paralysis of these functions and becomes an irritant. Consequently, our one effort is to avoid giving the infant a food which it cannot digest—firstly, because, not being digested, it will fail to be of the slightest use; and, secondly, because, as a result of the non-digestion, it will decompose in the intestine, and upset and disturb the infant very seriously.

I will sketch for you the treatment as we conduct it in this hospital, and then I shall endeavour to explain to you how, in the case of poorer infants, a

great deal can be done when the surroundings of such an institution as this are not available. An important part of our work is to lay down the principles upon which such cases should be treated outside the hospital, when we are not always provided with the exact materials that are here obtainable, and I shall hope to show you that we are by no means unable in such cases to do anything for the baby, as may at first be thought.

Let me take Case No. 106, admitted on February 12, 1904: a male infant, aged four months; weight, 6 pounds, 8 ounces. It was breast-fed for the first month; it was then fed on bread and milk for three weeks, and since then on cow's milk and water, equal parts. It always vomited after food. The intestinal dejections were infrequent and constipated, being one every other day. The baby was an in-patient at St. Bartholomew's for two days, and the case was then transferred to this hospital.

I will ask you to follow carefully the prescriptions which I am going to put on the board, because I shall endeavour to illustrate the essential principles of treatment; that is to say, the principles upon which we must proceed if we are to achieve any continuous success. The baby was put on this prescription on February 12:

℞	Per Cent.
Fat	2·00
Lactose	6·00
Whey proteins	0·50
Caseinogen	0·15
Alkalinity	5·00

The amount of fat is about half that present in mother's milk or in cow's milk. The amount of lactose is rather less, only slightly less, than that present in mother's milk. The whey proteins are rather less than those present in mother's milk, while the caseinogen is present in an extremely small amount. In other words, we were endeavouring to give this infant a great deal of nourishment in a form which we thought it probable the baby could digest, while the proportion of those ingredients most likely to upset it was very small. We considered that the caseinogen was the element most likely, in fact almost certain to be, beyond the powers of the infant's digestion, if present in any but a very small amount. Thus you see that of the solids, sugar—a soluble food—is present in largest amount; fat is present in a considerable amount; the whey proteins are in good proportion, and the amount of caseinogen is extremely small.

On that food the baby gained by February 16th 3 ounces; the dejections were of normal colour, not constipated, and by February 19th it had gained a further 2 ounces, the dejections being normal. On February 19th the baby was put on a fresh prescription: instead of 2 per cent. of fat there was 2·25 per cent., all the other ingredients being the same. The baby was gaining slightly, and improving, and on February 23rd the food was again altered. This time the change was in the proteins: the whey proteins were increased to 0·75 and the caseinogen to 0·25. A very important point in our prescriptions in this

hospital is that when we are changing the diet, we change one element at a time—the fat at one time and the proteins at another. With a delicate infant we never change both together, because it is most important for us to determine if any pathological symptoms arise, what is the cause; and if we change one at a time, we are in a position to speak with comparative certainty. The baby continued to do well, and the food was kept the same till March 8th, when the fat was increased to 2·50. The fact that we kept that baby for so long on this food showed that we had met the indications; the baby was gaining, while the dejections were normal, and at the same time there were indications that an increase in the food would not be desirable, because it would be too much for the infant. There was another pause in alterations of the food till March 25th, when the fat was increased to 2·75, and on April 1st the prescription was as follows:

℞	Per Cent.
Fat	3·00
Lactose	6·00
Whey proteins	0·75
Caseinogen	0·40
Alkalinity	5·00

You see we had raised the caseinogen from 0·15 to 0·40. The baby was discharged, weighing 9 pounds 4 ounces, having gained 2 pounds 12 ounces since admission. And I pass round the chart of another infant treated on the same principles. The infant was admitted on December 20th, 1905, aged fifteen months, weighing 7 pounds 3 ounces.

I promised that, having given you a sketch of the treatment in hospital, I would endeavour to show you how it may be carried out outside the hospital. We have here a pint of ordinary whole milk, and a small quantity of rennin. Remember that this is whole milk, because with skimmed milk the constituents of the whey which we are about to make would be different. To 1 pint of the milk, warmed to 100° F., I add a teaspoonful of rennin, and I carefully stir the milk so that when the rennin acts and precipitates the curd, about half the fat will be carried down with the curd, and the other half will remain in the whey. The milk has curdled, and we will now filter it through this piece of muslin. In this beaker we have the whey, and I will pass round the beaker containing the precipitated curd. When you realize its density, you will not be surprised at its causing severe indigestion in a young infant. If you wish to mix the whey with any milk, you must be careful to raise it to 150° F., because the rennin ferment is present, and would precipitate the curd from the added milk unless killed by being raised to this temperature. Now, I am in a position to show what you can do with ordinary milk and a little rennin ferment in the way of preparing food for a delicate infant. The composition of the whey I have made is approximately as follows:

℞	Per Cent.
Fat	2·00
Lactose	5·00
Whey proteins	0·90
Caseinogen	*nil*

Thus we have eliminated the caseinogen, and we have a food containing 2 per cent. of fat, 5 per cent. of lactose, and 0·90 per cent. of whey proteins—a very near approximation to my original prescription. Let me recommend that to you as one of the means which may be used for the purpose of feeding an atrophic infant. Of course, the more we understand of the precise composition of whey and of milk, the more we shall be able to adjust it to the precise needs of the infant.

But supposing the baby is progressing, and it needs a stronger food. Raise the whey to 150° F., then add two teaspoonfuls of whole milk. Thus you can gradually introduce the small element of caseinogen which appears in the prescription I wrote on the board. If you are in a position to feed the infant properly in the way I have indicated, it is not usually necessary to have recourse to other ingredients; but the infant may be of seven or eight months of age, and it may be able to take starch. You have the whey, and you have added a small amount of this milk, and you find you cannot add further milk without upsetting the baby. In those circumstances, take a little flour—a teaspoonful to a pint of milk—and rub it up with a little cold water first. It is important to get all the lumps out of the flour. Having rubbed it up with a small amount of cold water, you add it to the mixture at 150° F., and you are thus adding some proteins and starch, and are constructing a food containing fat, lactose, proteins, and all the materials necessary for the development of the infant.

I think, if you will follow out that method, study the composition of whey and the methods we carry out in this hospital, you will see you can do a great deal to help the poorest babies in the most trying circumstances.

Should this method not be available, another measure may commend itself. Here I have a tin of condensed milk. It is different from that usually known as such: it is a brand of unsweetened condensed milk—that is, it is simply milk from which two-thirds of the water have been driven off, and the proportions of the constituents in this tin are as follows:

℞	Per Cent.
Fat	12
Lactose	15
Proteins	8

Obviously, such proportions as these are beyond the digestion of the infant; but it will occur to you at once that a mixture which contains such a large proportion of food elements is a very valuable article. This tin of 16 ounces represents about 2½ pints of milk. It has one great disadvantage—that it is sterilized, and therefore, when using this, I would recommend you to give a small quantity of orange-juice, which will neutralize to some extent the prejudicial effects of a sterilized food. For a delicate infant take 1 part of this milk and add 11 parts of water. We then have a food of the following composition:

℞	Per Cent.
Fat	1·00
Sugar	1·3
Proteins	0·75

The fat is low, the sugar is low, but for a delicate infant the 1 per cent. of fat and 0·75 proteins may be valuable. It is necessary in using this food to supplement it with some sugar, preferably milk-sugar, or, if that is not available, the best form of cane-sugar, such as castor-sugar, and you may add 2 tablespoonfuls to each 20 ounces.

Atrophy is but one phase of the results of infantile malnutrition. In my next lecture we shall discuss another phase—that presented by the disease known as rickets.

LECTURE VI.

RICKETS.

THE disease that we are to discuss this afternoon is one of the most remarkable known to us. It is peculiar to infancy and early childhood, and its most remarkable feature is that it is a disease of *growth*. I may for a moment recall to your recollection the subject of our last lecture—Atrophy—only to remind you of the difference between the conditions to which we give the name of atrophy and those that are characteristic of rickets.

In atrophy there is a failure to develop. The functions which the infant should possess are greatly lacking, with the results that I described to you. In rickets we see the characteristic features of the disease in the shape of abnormal growth, a perversion of structure, and the alteration of normal conditions when we view the structures with the naked eye or with the microscope.

The disease is caused, essentially, by defective diet. Other alleged causes, such as bad air, overcrowding, insanitation, and other conditions of which you have no doubt heard, cannot possibly produce rickets if

the baby is properly fed. In the poorest quarters you will find babies absolutely free from rickets. In my lecture on *The Present Conditions of Infant Life, and their Meaning*, I drew your attention to the practical absence of rickets in some of the poorest Jewish centres, the reason being that although they may suffer from insanitary conditions, they do not suffer from absence of proper food. Let me remind you also that the disease only occurs in infancy and early childhood, and to save you from confusion, particularly in this respect, I must explain that the term 'congenital rickets' is a misnomer. No baby that has ever yet been born has been born with rickets. There is a condition resembling the disease in some respects, but on examination the resemblance is found to be a purely superficial one, the conditions which have been described as congenital rickets belonging to a different disease altogether. This is a branch of antenatal pathology with which I will not trouble you at present. But no baby is born with rickets, and therefore there is no such thing as congenital rickets.

It is a very common idea that the disease is confined to the bones, and that the whole effect of the disease falls upon the bony skeleton. Some of the most characteristic features of the disease are seen as they affect the bones, but I wish to impress upon you that there is no more generalized disease than rickets. It affects the whole structure — the muscles, the ligaments, the organs of digestion, and the whole nervous system. As a matter of fact, some of the late bony deformities which are frequently seen, and

are described as the results of rickets, are not so much the results of the disease itself as the results of the attempts of Nature to counteract the effects of the disease—they are Nature's attempt to provide a remedy.

Rickets, then, is a disease implying wrong structure. I cannot do better, I think, in explaining its nature, than to ask you to study the erection and structure of a building, because all the defects of rickets are precisely of the same kind as the defects to be seen in an improperly built house. If, for instance, you use mortar improperly made, if you do not use proper lime, or the sand is not of the requisite quality, or if you do not mix the materials in their proper proportions, then your mortar will be very poor stuff. In the same way, it is necessary to pay attention to the quality of the bricks, having regard to the task they have to perform, and to study the composition and capabilities of all the materials that are used.

It is precisely the same with the infant. In rickets, at the time that the infant is growing, the materials which are requisite for the growth of the tissues are of very inferior quality. The necessary consequence is that the whole of its structures are abnormal and pathological. I explained to you that the defects in the bones are by no means the only defects seen in rickets, but they do afford a very striking illustration of the precise character of the disease. In the development of bone we have certain features which serve to emphasize and illustrate the diseased processes. Let me take, for instance, one of the long

bones, such as the femur. Long before birth the centre for the ossification of the shaft arises, so that the cartilage is gradually converted into bone. But the centre of ossification for the two ends of the bone is much later in appearing, and in these situations the cartilage continues to proliferate during the whole period of growth from infancy, through childhood, till the adult stature is reached. By this means the bones are able to increase in length.

I will sketch upon the board the microscopical appearances of a section of cartilage developing into bone. Supposing we take a section through the bone, and view the cartilage developing into bone. *Here* we find a mass of normal cartilage cells set very closely together. A little lower in the section we find rather larger cells, preparing for their function in development. At a lower stage in the section we then find in perfect order certain cartilage cells proliferating; they now become rather different in shape, and appear in well-defined columns. *This* is the 'blue zone.' In this situation a change is taking place in the proliferating cells: they are becoming bone cells. And here we have the trabeculæ of bone. In this sketch, therefore, we see the stages of bone development—cartilage cells, enlarged cartilage cells, the proliferating zone, and then the definite bone formation.

And now, by means of the Epidiascope, I will project upon the screen the microscopic image derived from the actual sections, so that you can observe for yourselves the nature of the rachitic lesions. The

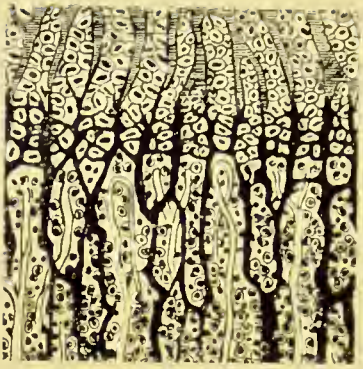

FIG. 6.—MICROSCOPICAL APPEARANCE OF NORMAL BONE-FORMING TISSUE.

FIG. 7.—MICROSCOPICAL APPEARANCE OF BONE-FORMING TISSUE IN RICKETS.

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first section is one illustrating normal bone development (Fig. 6). You see at the top of the section normal cartilage cells. A little lower down you see them larger and more discrete, and then we find the long columns I sketched on the board. Now we come to the area of actual bone formation, and you see how narrow and how sharply defined it is. You see that you could draw your pencil above and below it without any difficulty.

Contrast this with the section I now project upon the screen (Fig. 7). It is a section through a rachitic rib at the junction of the bone and cartilage. You notice at once that the whole section is much larger. The proliferating columns are much longer, but where is the definite, clearly marked zone of bone formation? It is conspicuous by its absence. *Here* you see a long column of cartilage cells; then comes a mass of spongy bone, and *below* this you see, again, cartilage cells. This is typical of the disease; but a little lower down still, we find an even more characteristic appearance. You see these cells with a black network. They are calcified cartilage cells. The lime has been deposited *not* in the newly formed bone, but in cartilage cells. That is a permanent deformity, which cannot be eradicated. You see the bulging of the section in this situation, and everywhere in this intermediate area you see a heterogeneous mixture of wrong tissue, neither good cartilage nor good bone. And now I will throw upon the screen the photograph of a child of two years suffering from the disease. You see the square-shaped 'bossy' head, the deformed chest, the protuberant abdomen, the

deformed limbs; and you see particularly clearly the enlargement at the wrists caused by the processes I have demonstrated to you. And when you see these cases, I think it will help you to realize their full meaning and nature, if you bear in mind the appearances as we see them under the microscope.

I have here a rabbit's bone, part of which was placed in hydrochloric acid to remove the lime, so that one end is quite soft. The fact which this specimen illustrates has led to a very curious error in regard to the causation of rickets.

It is perfectly true that in rickets the mineral matter is much less than is normally present in bone, and that has led to the idea that the chief cause of rickets is due to an absence of lime or calcium in the food—so much so that the rickets which is so common among the children in Glasgow was attributed to the purity of the water from Loch Katrine and its freedom from lime. Now, as a matter of fact, a deficiency of lime is very seldom found in babies' diet. You have heard me dwell upon the serious defects of patent foods, but you have never heard me say they do not contain enough lime —they all contain a large amount of lime. Not only that, but when you dilute ordinary milk with two parts of water, there is as much lime in that mixture as there is in mother's milk of good quality. Consequently, we cannot attribute any of the defects as we see them in rickets to a deficiency in the supply of lime; very often the rachitic baby has had much more lime than it could possibly require. So that, though the removal of lime shows how soft the

bone becomes, and how useless it would be but for the lime, yet the growth of the bone depends on the production of the *matrix* in the shape and character that you see in that bone, which is quite independent of the lime. It is the deposition of lime in the perfectly formed structures which makes good bone. If those structures cannot be formed, the lime is deposited anyhow; then you get the rachitic bone. I may remind you that as a result of late rickets the bone contains more lime than is normally the case, and the bone is much denser and more brittle. It is an ill wind that blows nobody any good; and some of the rachitic deformities of the skull provide the professor of 'phrenology' with a steady source of income.

Let me now summarize some of the chief characteristics and results of rickets. In the first place, it has a most serious influence on the nervous system. Very many infants die from convulsions at about twelve months of age; practically all of these deaths are due to rickets. There is not the smallest doubt that it is a very common cause of epilepsy in later life, and it is one of the great causes of insanity. The injuries done to the nervous system by rickets are appreciated at the present time by very few; but the more you study infantile conditions, and the more you study the conditions prevalent in lunatic asylums, the more you will realize that the preventable causes of insanity lie chiefly by the disease which we are discussing this afternoon. The whole structure of the nervous system is wrong; the performance of its functions becomes

quite unbalanced, and, in the result, you have sometimes the epileptic condition and sometimes the condition of insanity.

To take you from that to a quite different aspect of the matter, there is very little doubt at the present time that the chief cause of adenoids is rickets; the condition which we know as the scrofulous condition with enlarged glands is one of the common sequelæ; while pulmonary tuberculosis would very largely cease to exist if it were not for this disease. If you go to any chest hospital, and put on one side the patients who do not exhibit signs of having suffered from rickets, you will not find many patients left who are under treatment for tuberculosis. The incidence of pulmonary tuberculosis as it affects the young adult is determined by the destruction of the resistance of the body by rickets, assisted by the deformities of the chest, which are such a marked feature of an advanced case of rickets. Let me remind you of the spinal deformities which are seen in practically all classes of society as the result of the same disease. Dr. Clement Dukes has stated that, of the boys at Rugby School, a very large proportion exhibit signs of defect due to infantile malnutrition. Any competent physician will tell you the same thing in reference to the spinal deformities one sees in practice. In lying-in hospitals we see rare forms of pelvic deformity which cannot be etiologically accounted for; but if we put all these rare forms together, they would not bear comparison in number with the deformities of the pelvis caused by rickets. And throughout this list—and I might easily add to

it—there is nothing surprising, because, as I explained at the outset of my lecture, rickets is a disease of growing structure, and if you have conditions in which such structural defects can manifest themselves owing to a defective supply of building material, the lesions must be widespread, and extending to every organ of the body. Thus we have all these conditions due to rickets.

What are the defects in the diet which are responsible for the disease? The first great factor is deficiency of fat. It is very seldom that one sees a baby suffering from any marked form of rickets if that baby has had a sufficient supply of fat. Next to fat comes a deficiency of proteins. But most of the severe cases of rickets I have seen have been caused firstly by the deficiency of fat, assisted by a deficiency of proteins. There is not the smallest doubt that from a deprivation of fat, and also a deprivation of the necessary protein material, the worst cases of rickets result, and the most powerful factor in the causation of the disease is the absence of a due supply of fat as found in milk.

One other point I must explain, however, in reference to this deficiency. Remember that food materials may be present in milk which are destroyed by the treatment to which the milk is subjected, and in this respect there is nothing so likely to injure the properties of milk as boiling it. I see many babies who have received a considerable amount of fat and proteids in their diet—and as regards the actual amount one could not say the supply was defective—but the milk has been sys-

tematically boiled, the properties of the fat and proteids as they exist in milk have been destroyed, and so the infant has, for all practical purposes, been deprived of the elements which are in the milk, but which are not present in a form in which the infant requires them.

I must not forget to inform you of one rather important matter in reference to this disease. We seldom see a well-marked case of rickets before about twelve months of age—that is to say, the rachitic 'rosary,' the enlarged epiphyses, the big head, the swollen abdomen, typical of rickets, are more likely to be seen during the second year of life than they are at nine months. But the most important stage of treatment is at the time when not one of those signs can be seen. It is altogether dependent on the point of view you take whether you describe rickets as a disease of the second year of life or of the first six months. Those exhibiting the marked signs of the disease are nearly all of them over twelve months of age. On the other hand, if you take the view which we take in this hospital, you will say it is a disease beginning in the first six months of life as a rule, and practically always beginning in the first twelve months.

What are the symptoms of the baby suffering from the incipience of rickets? They arise in the digestive system, for it is there that the diseased processes begin; and if we are watchful and aware of the signs that lead to rickets, we shall be in a much better position to protect our patients from the disease.

The first sign is constipation. It is particularly liable to occur in breast-fed infants. They have gained in weight; they have 'thrived.' Beyond a little fretfulness nothing particular is wrong, except that the mother gives us a history of marked constipation. I remember in particular the case of a baby weighing 17 pounds at seven months of age. The baby had suffered from constipation ever since it was three months old, but otherwise there was 'nothing wrong'; the mother was very pleased, and it was not till this trouble had given rise to more and more difficulty that I saw the baby.

I analyzed the mother's milk, and found it to contain 1·25 per cent. of fat. I took that baby in hand at once, saying that it would take a long time for me to get it really right, that its teething would be very late; but that I should probably be able to counteract most of the symptoms of rickets other than that. As a rule, when a baby of seven months has not teethed, that baby is suffering from rickets—a very early stage of the disease, perhaps, but a very important one.

In all the babies I have had under my care that have been substitute-fed throughout, there has not been a single baby that has not teethed by seven months of age. That is a most important fact, because the development of the first teeth are not only important in themselves, they are the precursors of the second teeth. The enamel germ is forming at that time, and anything that delays or injures the first dentition prejudicially affects the second dentition. The great cause of the decaying teeth among

us all at the present time is rickets in early infancy, particularly as it affects the teeth, so that the primary teeth begin to appear at the ninth, tenth, or eleventh month, instead of at six months. I quoted that one infant just now because only one marked symptom was present; but with every precaution taken to neutralize the conditions as far as possible, the baby did not teethe till about ten months of age.

Before leaving the subject of constipation, I should refer to the characteristics of the intestinal dejections in these cases. You will frequently find masses of food are undigested; the colour of the dejections is abnormal, and they show a great tendency to become whitish and like clay. The normal dejections in the infant should be without odour; in these cases they become extremely offensive. That is one of the characteristics of the intestinal conditions of early rickets.

The next symptom one should watch for is restlessness at night. The infant throws off the clothes, and tosses about very restlessly, so that the nurse reports that it is difficult to keep the clothes on the baby. At the same time that you obtain that history, you will learn of another important feature—sweating of the head. In all cases of rickets at some time or another it is one of the symptoms of the disease, and in some cases it is a very marked feature.

The actual condition of babies varies very much, according to the expression which the disease has taken. In some babies you will see the rachitic

'rosary' very clearly, and perhaps that is the typical sign of the disease. At other times extreme flabbiness is the most marked feature; and, of the two, the extreme flabbiness is rather the worse, because it means that all the tissues and muscles and ligaments are definitely affected. When we come to treat this condition in the baby, we very often find we have great difficulty. It is usually a big baby, very flabby, very heavy, with all its tissues wrong (Fig. 8). The mother and the nurse have been loading this baby up with more and more food, in the endeavour to induce a gain in weight, because it is not thriving. There sometimes ensues a battle between the mother (very likely assisted by the nurse, if she is not sufficiently trained) and the physician. In such cases as that, it is imperative that loss of weight should occur. You will remember, in the sections that I projected upon the screen, I demonstrated the large amount of material, and the amount of wrong material. All that wrong material has to be got rid of throughout the body, whether in the brain, or the bones, or the muscles, before we can get the deposition of good healthy tissues. The one tendency of the mother and nurse is to load the infant with food, to supply it with milk, bread and milk, and so on; while the wish of the physician, who is anxious about the case, is to get the digestive organs into order, to correct the intestinal conditions, to get a loss of weight, and to throw the baby on its own tissues. Since we have to get rid of this wrong tissue, the only method of getting rid of it is by burning it up—that is, by oxidation. If we deprive the baby of fat and proteins,

it must go to its own tissues to maintain its heat and functions, and thus break up and remove the degenerate material. So when you have a heavy rachitic baby to deal with, do not be alarmed that it is losing weight—that is a matter for congratulation; for if it continues in that condition of gross flabbiness, it will very likely die of convulsions. The nurses in this hospital see a great number of atrophic infants, but they seldom see infants in convulsions. However much the atrophic infant may suffer, it does not suffer from convulsions. The typical baby to get convulsions is the one I have been describing to you as the flabby rachitic baby.

Remember, also, that some of those babies presenting all the cardinal signs of the disease not infrequently get a prize at baby shows as being fine specimens of nutrition. A baby that I know of gained a prize—it was two and a quarter years of age, and it could not walk.

The treatment of rickets is essentially dietetic, and the adjustment of the diet in all cases must be governed, not by the condition of the bones and ligaments, but entirely by the condition of the digestive system. First get that clear, and the liver acting better, the intestinal dejections normal, the appetite healthy, and then you may gradually proceed to increase the food. As you increase the food, remember that fat is the element which should be increased within moderate bounds, as being the one element essential for the perfection of the structure, and for the correction of the various defects. Nothing will cure the nervous manifestations of rickets so

quickly as a due supply of fat. Remember, also, in dealing with flabby babies that a due supply of the protein element is very important, and keep the sugar down, so that the baby may be able to burn up its own tissues as far as possible, and eliminate the rachitic material.

LECTURE VII.

'EPIDEMIC DIARRHŒA.'

THE disease which is the subject of our lecture this afternoon is one that has been known by many names. Of the more common, I may mention summer diarrhœa, cholera infantum, and zymotic enteritis. It is a disease peculiarly liable to appear at certain parts of the year, and is practically absent in many other portions of the year. The conditions in which the disease arises occur during hot weather, and especially during a hot summer. The characteristic of the disease in regard to the date of its appearance is that it is towards the latter end of the summer, when the heat has continued for some considerable time.

A great deal of interest has been displayed by some in the temperature, as recorded by an instrument known as the 'four-foot thermometer.' This instrument records the temperature of the soil at a depth of four feet. As a rule, it is not until this thermometer reaches a certain temperature that the maximum incidence of the disease is seen, and much theoretical speculation has been indulged in with

reference to the meaning of these observations. There is very little in the meaning of the temperature as recorded by this thermometer. A raised temperature at a depth of four feet merely means that the heat must have continued for a considerable time before the soil at this depth is materially affected, and, therefore, it is not till the heat of summer has lasted for some time that the four-foot thermometer rises to its maximum level. That is all it means, and nothing else, and many of the extraordinary theories which have been advanced in reference to this temperature have no basis in fact.

As a mortal disease affecting babies, epidemic diarrhœa is the most serious of all. The number of deaths depends, at the present time, solely on the temperature. If it is a cool summer, the number of deaths is comparatively low; if it is a hot summer, the number of deaths is very high indeed. The year 1904 affords a sad illustration. The summer of that year was very hot, and, in many towns throughout the country nearly one-half the babies under twelve months old died in the three months July, August, and September. These infants died because they were poisoned, and in order to explain to you the nature of the disease, it is necessary for me to deal with the very important question of its terminology.

I have taken as the title of my lecture the only authorized term at present, because it is the only official term—the term *Epidemic Diarrhœa*. The adoption of this name for the disease is much to be regretted. In the first place, it is wrong, because on all sound principles of the nomenclature of disease

we should always avoid labelling a disease by its symptoms.

You may be suffering from toothache: that is not a disease, it is only the means of drawing your painful attention to the fact that you are probably suffering from dental caries, and the disease is not the toothache, but the dental caries which gives rise to it. Therefore, the terminology of this disease is wrong, because the diarrhœa is not the disease at all —it is one of the symptoms of the disease, and, what is more, it is a symptom which represents an attempt of Nature to cure. It is Nature's attempt to void the poisons, and although the diarrhœa may be so exhausting as to kill the patient, nevertheless this does not interfere with the fact that the diarrhœa is an essential part of the process of removing the poisons from the infant attacked by the disease, so that the *motif* of the diarrhœa is essentially beneficent.

If the terminology in this respect is unsatisfactory, it is altogether misleading in another respect, because the disease is *never* epidemic. This is so important, that I must explain to you certain facts in regard to infants which are very inadequately appreciated at the present time. Babies are remarkably immune from all epidemic disease. Scarlet fever and measles are well-known typical epidemic diseases. They attack large numbers of the community, particularly children, but they very seldom attack babies. Chicken pox is almost the only form of epidemic disease that at all commonly attacks babies, and, as you know, it is one of the trivial forms. Not long ago, we had an

infant approaching the age of childhood in the hospital; it was attacked with measles, and we learned, when we questioned the mother, that her other child had been removed to a fever hospital suffering from the same disease. We remonstrated with her for bringing her child to the hospital without mentioning the fact. The baby was removed from the hospital, but not a single infant in the hospital contracted measles. I draw your attention to the facts in regard to this Infants' Hospital—the only one of its kind—because of the remarkable illustration it gives us of the conditions as they affect babies. Let me ask your special attention to the conditions of the old hospital in Hampstead, for the fact that that was by no means a fully equipped institution bears a very interesting relation to our investigations. It is an important point in the work of this hospital that we intentionally started with comparatively inadequate accommodation, because we were very anxious to put the views which we entertained to a very stringent test.

The old hospital was nothing more than a house in Hampstead, quite an ordinary dwelling-house, and the arrangements were as follows: An ordinary front parlour, an intermediate room of small size, and a larger room behind—these rooms, all communicating, constituted the ward. The sanitary accommodation was such as you usually find in a house of that size and character. In that ward we had twenty babies under treatment, and in the year 1904 we had six babies in the hospital at one time who had been admitted suffering from the disease known as epidemic

diarrhœa. No infant in the hospital ever *contracted* the disease, although we had six of them suffering from it when they were admitted. I think that should satisfy you that the disease is not of the nature of an epidemic, for there could be nothing more likely to spread an epidemic than bringing these cases among infants susceptible to it. But there was no epidemic of zymotic enteritis—not a single baby contracted the disease, and from the time the hospital was established to the present time, there has never been an infant who has contracted the disease in the hospital.

In the hot weather the disease suddenly appears, kills a large number of infants in a limited area, and then as suddenly disappears—there is a great deal in these circumstances of incidence superficially pointing to its being an epidemic. But there is one cardinal fact which stands out with regard to this epidemic, as it is called, and that is the infants who are not attacked by it. The cardinal fact is that the breast-fed babies escape; they are practically immune, and if they are attacked, the attacks are much slighter, and they generally recover. Moreover, you will generally find that the breast-fed babies who are attacked have been given other food in addition.

When we find such a remarkable feature in a disease as that, we are at once compelled to conclude that the epidemic theory falls very short of being the true explanation, because, of course, if you were to bring the epidemic of diphtheria, or of scarlet fever, or measles among those susceptible, you would at once find that large numbers of comparatively healthy,

well-fed children would suffer as well as the others. The facts as observed in regard to the hospital, and in regard to the feeding of the infants outside the hospital, point conclusively to the one cause of the disease—that is, that the babies are poisoned by the administration of food which is poisonous in its character.

Another leading feature in the incidence of the disease is also calculated to mislead those who have not the opportunities of very carefully watching and observing infants. The fact that it arises in the summer, and that there is suddenly a cry that the babies are dying with epidemic diarrhœa, or with the diarrhœa and vomiting which are so well known in all the London hospitals, inclines us to look upon it as a disease characterized by its suddenness of attack and its intensity of onset. It is *not* a sudden disease; it does *not* arise spontaneously or very quickly. It is, generally speaking, the result—the final result—of gastric and intestinal disorder. The fatal attack is the final expression of pathological processes which have been going on for some weeks, very often for months, past.

What is the disease? It is a filth disease, arising from the consumption of filth, and the fact that very large numbers of babies are attacked is only to be explained by the fact that very large numbers of babies are consuming filth. By filth I mean, for example, the ordinary milk-supply of London. We must realize the meaning of the condition of milk as it affects the infant at the present time.

The state of affairs at the average farm where

milch cows are kept is exceptionally filthy. The cowhouse is dirty, and in a great majority of cases insanitary in the extreme. Everything is permeated with cow-dung; the cows are covered with filth; the floor on which they stand is covered with an oozing mass of excreta. The diet of the cows is characterized by the exclusion of wholesome food, and by the substitution for it of brewers' grains, oil-cake, and other products having a definitely prejudicial effect on the milk.

In November, 1903, Dr. George Newman, Medical Officer of Health for Finsbury, published a report on the milk-supply of that borough. He found 90 per cent. of the milk had been brought from country farms. As a rule, the cowsheds were ill-lit, overcrowded, and badly drained. Of the milk-shops, 52 per cent. were found to have sanitary defects, and 73 per cent. of the vendors failed to keep the milk covered. The average number of bacteria in uncovered vessels was 2,370,000 per cubic centimetre. Pus and dirt were found in a large number of cases. Dr. Eastes examined 186 samples of milk from all parts of the kingdom. Pus or muco-pus was found in 134 samples, blood in 24 samples. According to the results of the examination, 80 per cent. of the milks were unfit for human consumption.

Milk is the finest medium for the development of bacteria, the result being that the development of bacteria in milk when not properly dealt with is enormous. Let me remind you of the rate of development of a single germ in milk. At 44° F. the development of a single germ is as follows: in

two hours, 4; in three hours, 6; in four hours, 8; in five hours, 26; and in six hours, 435. That is at a temperature of 44° F. Now let us take it at the temperature at which it comes from the cow—between 97° F. and 100° F. The rate of development is: in two hours, 23; in three hours, 60; in four hours, 215; in five hours, 1,830; and in six hours it is 3,800.

If you take milk and expose it at a temperature of 70° F. for fifteen hours, the bacteria that have developed number 72,000,000 per cubic centimetre. The development of bacteria in milk is, of course, of the utmost importance in regard to its purity. It is not only the number of bacteria that is harmful; for, as a result of the bacterial growth, *toxins* are produced, and the fluid in which the bacteria have lived and multiplied becomes loaded with noxious material.

Once milk has been affected by the growth of pathogenic bacteria, it is quite impossible that it can be of any good, and it must be a poison. Another important point is that sterilization will do little good. The toxins present in the milk as a result of bacterial development are there, whether you boil the milk or whether you do not, and all you do by sterilizing it is to give the baby dead bacteria instead of living bacteria. In the circumstances, it is better, if you are compelled to administer such milk to an infant, to boil it; but it is more useful to put it into the drain, for which receptacle only is it suitable. We must all realize that sterilization, however carefully conducted, can never convert dirty milk into clean milk. The essential thing is really pure milk.

The sterilization of milk very often results in one of the worst forms of the disease. It has been noticed by competent observers that some of the babies who have died most quickly, and who have shown the least resistance to the disease, are babies who have been fed for a considerable period on sterilized milk. The reason is a very obvious one. As the result of the infants living for a continuous period on sterilized milk, their digestive functions become very largely perverted. The vital activities characteristic of the whole alimentary tract are largely absent because the processes which go on when pure, unheated milk has been given are impossible with a fluid so changed in its character as is milk when it is sterilized. Very frequently, therefore, the infant develops specific liability to the disease by reason of the pathological fermentations going on in the intestines. The intestine of the infant becomes a human culture-tube, and when it is inoculated with the poison the whole of the material is simply so much food for the bacteria to live upon and produce the toxic products which kill their victim.

Before discussing the signs and treatment, let me draw your attention to the most important thing in regard to the disease. Remember it is not a sudden disease; it is nearly always preceded by a period of gastric and intestinal disorder. That, therefore, is the time when we should be on the watch, and particularly when the hot season is approaching should we give all possible attention to any indications of gastric or intestinal disorder.

Especially should you watch the flabby baby I have before alluded to in these lectures, with pasty, ill-digested, clay-like dejections. That is the typical baby to contract the disease in its worst and most fatal form. Such a baby seized with the disease becomes so ill in the course of twenty-four hours that its recovery is practically out of the question. It has been ill for a long time; it has been flabby and weak, exhibiting the symptoms that I have described; and, when zymotic enteritis makes its appearance, it is without the power to stand against it.

Therefore, our great object is to secure for the infant, as far as we can, firstly that it should be breast fed, if possible; and, if that is not available, that our methods of feeding should be carried out with the purest milk obtainable.

If the milk is not safe, we should pasteurize it at 150° F. for fifteen minutes. This process, while injuring the milk to some degree, does not do anything like the injury boiling does, and at 150° F. all disease-producing organisms are destroyed. Dealing with the babies of the poor, if you can arrange that the milk is raised to 150° F. for fifteen minutes, you are protecting it from all bacteria that are disease producing, and that milk will keep with care for forty-eight hours or longer. The milk heated to 150° F. gives the reaction which raw milk gives, and which milk heated above 160° F. does not give. Therefore, if you keep to 150° F. you will avoid most of the serious injuries done to milk by boiling it.

The signs of the disease may now receive our consideration. In mild cases the onset is gradual,

being accompanied by fever of a moderate degree. Gastric disturbance is not a marked feature. Diarrhœa develops gradually; the motions become more frequent; their colour changes from yellow to green, and they become watery, acid, and offensive, and contain masses of undigested food.

The infant is pallid, very weak and apathetic, and cries persistently: the weight rapidly decreases. These cases are the most hopeful when treated with the necessary care and attention.

The acute cases present somewhat different features. The infant, apparently well, suddenly becomes ill. The skin is hot, the temperature rises rapidly, and the infant shows all the signs of severe distress, draws up its legs, moves restlessly, continually writhes with pain, and sleep is almost entirely absent. Vomiting is generally the first sign, and may be extremely severe: at first the infant vomits food, and then retching of a continuous character sets in. No food can be retained by the stomach; even water may fail to be retained. Diarrhœa ensues in the course of twelve hours from the initial illness. The motions are of the character previously referred to, except that the diarrhœa is much more marked. The intestines constantly acting, the discharge becomes quite fluid, almost colourless, and sometimes very offensive; the amount of fluid lost may be very large, and the infant visibly shrinks owing to the loss of fluid from its tissues. In the worst cases the signs are characteristic. The pulse is weak and rapid, the crying, so prominent in the earlier part of the attack, ceases, and is replaced by

feeble moaning. The cheeks sink inward, and we see a space between the eyelids and the eyes, which remain open during sleep, owing to the loss of tonic muscular contraction. Profound collapse ensues; the temperature, at first high, becomes subnormal, the extremities are cold and flabby, thrush invades the mouth, and the infant passes into a condition of stupor, and then dies.

In the treatment of the disease, the first essential is to eliminate all poisonous material. Castor-oil should be first administered in the earlier stages, even though it may increase the diarrhœa. Give a good dose of the oil, with the view of assisting the elimination of poisonous materials. To counteract the tendency to collapse, alcohol is very valuable—5 to 10 minims of brandy may be given, according to the age of the infant, in a teaspoonful of warm water. Small and frequent doses of calomel are frequently given with great advantage in counteracting the decomposition that is proceeding. In cases of persistent vomiting stomach washing by means of the stomach-tube is sometimes useful; but the most valuable method of treatment is irrigation of the colon. The apparatus consists of tubing and a douche-can containing 1 quart of normal saline solution at 100° F. Some physicians recommend antiseptic solutions in these cases; my own experience is that antiseptics are of very little use, and sometimes do harm. The only effect of colon irrigation is the physical effect of removing material inside the colon. I am not disposed to recommend the addition of any drug except the amount of salt to make normal saline

solution. The buttocks should be elevated, so as to ensure the flow of the fluid into the colon. This is best effected by laying the infant on a table and bringing the buttocks, elevated by pillows, to the edge. It is very important to guard against hydrostatic pressure, which would rupture the colon. The douche-can should be very gently raised, and the elevation should not be greater than necessary to admit the gentle flow of the solution into the colon.

A very important practical point is that no attempt should be made to pass the tube beyond the rectum until the fluid flows readily out of the tube. In infants of six months a pint should be introduced before the solution returns. As a rule, not less than 4 pints of the solution may be used, and frequently this amount may be doubled. With such a thorough washing as that, you may rid the colon of a large amount of material, and you will further induce the small intestine to pass the injurious matter rapidly on to the colon, and thus rid the baby of the putrefying material which is poisoning it.

This, then, is the first and most important part of the treatment—the elimination as far as possible of the contents of the whole of the intestines, small and large. Any attempts to feed the infant will be altogether useless so long as the food you are giving can combine with the putrefactive material inside the intestine. In such cases, administration of food means that you are providing more food for the bacteria to decompose, and you are assisting the bacteria which are threatening the life of the infant. By thorough irrigation you are most effectually re-

moving the bacteria together with the material upon which they thrive.

The pathological processes never take on their most serious and fatal form unless the small intestine has become alkaline. As long as the whole of the small intestine is acid the development of the poisonous bacteria cannot take place. The processes causing this disease cannot flourish in an acid medium, and consequently diarrhœa occurring in cases where the contents of the small intestine are acid is not serious. The next most important point to bear in mind is the urgent necessity of keeping the infant warm. For this purpose we may use hot-water bottles, or any other safe measures which may assist the infant to maintain its natural heat, and thus help it to ward off the collapse which always threatens in these cases.

What shall we do when we begin to feed the baby? The first thing is very dilute food. As a result of the illness, the baby's digestive tract is in an irritated condition, and there is great liability to decomposition of the food if it is not properly absorbed by the infant. A little albumen-water is one of the first things to be administered. Following upon that, whey is a very useful food, and you may gradually increase the food materials by adding milk in small proportions by the method that I described in my lecture on Atrophy.

Whenever we have to deal with such a disease, we must remember that all our treatment must be radical and *immediate*. With the onset of the disease the procedures I have described should be carried out without delay, and, having carried those out, we should give our attention to the precise dietetic requirements.

LECTURE VIII.

GASTRIC AND INTESTINAL DISORDER.

This afternoon I propose to make a cursory survey of the conditions of gastric and intestinal disorder, as they are met with in young infants. That covers a very wide field, the peculiar disorder being determined largely by the nature of the disease affecting the infant. As it is very important that we should realize precisely the conditions affecting the infant, we should note with particular attention the precise features of disorder, so that we may appreciate the meaning attaching to particular symptoms.

Very different functions are performed in relation to digestion by the stomach, the small intestine, and the large intestine. The stomach is very largely a safety-valve. It does not take part in the essential processes of digestion; it cannot, for instance, absorb water at all, and it is of small size compared with the length and bulk of the intestine. The essential function of the stomach is to prepare the food; certain preliminary processes take place which are of great importance, so that when it comes to the intestine the food is in a condition in which the intestinal secretions can most perfectly deal with it.

It is a regulator. At the end of the stomach and the beginning of the intestine the pylorus is situated. This is surrounded by a powerful muscle, which is very frequently in a state of contraction, and only expands at intervals, thus admitting the passage of food to the intestine at one time and preventing it at another. When a baby is fed with food of a highly irritant, perhaps poisonous, character, vomiting generally ensues. The vomiting is a sign that the food is injurious, and if it were passed into the intestine the infant might be killed. The ability of the stomach to reject injurious materials protects the infant from more serious injury. Vomiting, then, is one of the characteristic features of gastric disorder. It is well, therefore, for me to draw your attention to the peculiarities of vomiting as we commonly see it in babies.

Firstly, we find it occurring very shortly after feeding; within a few minutes the baby returns a slight amount. If it is nothing more than that, and is not a very frequent condition, we may look upon this as an adaptation by Nature to meet the exact conditions. The infant has taken rather more food than it can deal with, and the stomach returns the excess. A small vomit very soon after food, the infant being well in other respects, is not as a rule a very important sign of disorder, and we may frequently disregard it, other things being equal. On the other hand, it is not a good sign if it is at all marked or at all constant; this means, at least, that the stomach is being systematically distended; that the infant, receiving more food than

the stomach can accommodate, is compelled to reject it. In such circumstances distension of the stomach is likely to occur, and while an occasional distension may not be harmful if in a moderate degree, still, if that distension is continually occurring, great harm is likely to ensue. It is apt to lead to permanent gastric dilatation.

The next kind of vomiting is one occurring at about half an hour to one hour after feeding. This should give rise to considerably more anxiety. The fact that vomiting has occurred at the time of feeding shows that the amount, and not the material, is troubling the infant; but vomiting at the end of half an hour to an hour indicates that, digestion having proceeded for some time, the results of that digestion are injurious to the infant. The stomach is compelled to reject the partially digested food by reason of its irritant action: and this is an indication demanding our attention. The characteristic symptoms of this condition are that the baby is suffering from discomfort or pain, and relief is obtained as soon as the vomiting occurs. The varieties of this vomiting are many. In the case of improper feeding, where, for instance, there is a large amount of cane-sugar or maltose, as in patent foods, fermentative changes are taking place in the stomach, giving rise to products of a highly irritant character, so that the baby is compelled to vomit them. Very often such cases are attended by periodical skin eruptions, due to the absorption of the bodies produced by these pathological fermentations. Very frequently the baby vomits a large

amount of tough, tenacious curd. This curd is formed by the precipitation of the caseinogen in milk combined with the lime-salts. And we should at once consider the precise quality of the food of the infant, because the amount of proteins, or the character of the proteins, is probably altogether wrong.

There may be another form of vomiting largely associated with the class of case I have been describing, in which, after an initial vomit, the baby continues to vomit at irregular intervals; or, instead of the initial large vomit, you may find that the baby is frequently and persistently vomiting small amounts of curd and sour-smelling fluid. In such cases as that there are clear indications that the whole of the gastric digestion is in a pathological condition; and not only have we to think of the suffering of the baby as regards vomiting, but we have to remember that if the baby is continually vomiting this peccant material, a certain amount is also passing into the intestine, producing much disorder throughout the alimentary tract.

Then, there is a distinct type of vomiting seen as a result of malnutrition, and it is of rather a curious character. It occurs, as a rule, rather later after feeding than the one I have been describing, and is characterized by the fact that the baby vomits *clear fluid*. It is very often a large amount; the amount, indeed, is so large that in some cases it gives rise to some wonder as to where the baby derives the amount of fluid from. For instance, a baby may be receiving three or four ounces of milk or milk mixture; it does not vomit any curd, but perhaps

two and a half hours after the feed it vomits this clear watery fluid. You examine the vomit, and you see that it has practically none of the characteristics of milk; there is no curd and no fat, and, consequently, you infer that it cannot be by reason of the milk having caused indigestion. The amount may be so large that the pillow may be wet, and the baby's garments may be thoroughly soaked by the amount of the fluid vomited. Another characteristic of this condition is the irregularity of occurrence, the baby going perhaps one or two days without vomiting, and then suddenly vomiting large amounts. By large amounts I mean some ounces of fluid. To what is this due? It is a very interesting condition, allied to one which we know as hyperchlorhydria, and which is seen in neurasthenia, especially in women. It is due to the state of the nervous system, which fails to control the secretion of the digestive glands, and at intervals the glands pour out this watery fluid. It is also a very interesting condition as regards treatment, because while in most cases of vomiting one would do well to decrease the food material, in such a case, as a rule, by far the best treatment is to increase the amount of fat. You will remember what I told you about Pawlow's researches, and how fat inhibits gastric secretion. The administration of fat acts on the mucous membrane of the stomach in preventing, as far as may be, the secretion of this fluid, and at the same time provides the nutritive material which is required for the nervous system of the infant.

Such vomiting may occur in other conditions

where the nervous system is disturbed. I remember seeing a case some time ago of a baby who had been fed by a wet-nurse. The wet-nursing was stopped, and feeding by means of modified milk was begun. It did not vomit the milk, but about two and a half hours after the first feed the baby vomited clear liquid. In addition to the vomiting, the baby presented some alarming symptoms. Its eyes were turned upwards, convulsions were threatening, and I very much feared that there might be some cerebral disease, or that some grave constitutional condition was affecting the infant. That, however, was not the case, and the reason in that particular baby for the vomiting was a condition of intestinal obstruction, due to a mass of undigested fat and proteins in the first part of the small intestine. A little later, the analysis of the wet-nurse's milk reached me, and I then learnt that her milk contained a very great excess of fat. As a matter of fact, it was when the modified milk reached the intestine and could not pass further, that these irritant signs arose, and as soon as the intestine was cleared all these symptoms disappeared. So, remember, that if you have a case of constipation caused by a large amount of fat in the intestine, you may witness symptoms similar to those I have described.

One other characteristic kind of vomiting I may refer to, although it is not common in infants, but is common among fairly young children—cerebral vomiting. It is characterized by its suddenness: gushes of fluid pour out of the infant, and one of the prominent features is that the contraction of the

stomach in these cases is so powerful that the baby seems to be taking no part in the process—the stomach seems to be acting, and the baby seems quite independent of it. The vomit shoots out sometimes a considerable distance from the baby. That is the characteristic cerebral vomiting, when, for instance, there is a tumour in the brain. We see it occasionally in babies where there is cerebral irritation. This kind of vomiting, and the vomiting of the clear fluid, which I have described, rather tend to merge one into the other; but definite cerebral affections of an organic character are seldom seen in infants.

Let us now discuss the treatment of these conditions. Firstly, as regards regurgitation of a small amount of food soon after feeding. It may be due to too much food. The remedy in such cases, of course, is a very simple one, and that is to reduce the amount. But another very common cause is that the food is taken too quickly. In the natural method of feeding, the infant experiences considerable difficulty, and it has to make an appreciable effort to obtain its food. That means that every now and again the infant relaxes its efforts; the food is not continually passing into the stomach, so that the stomach has a much better chance of accommodating itself than if the food is poured rapidly into the organ.

Unless substitute feeding is properly controlled, the common tendency of the baby is to get the food too quickly. I may draw your attention to the precautions we take in this hospital to prevent this. The tube we use in the hospital has no valve; it is simply a glass tube with a small orifice at one end. On this

end is placed the mouth-piece, and it is pressed down for about one inch over the shoulder. The tube is then elevated, and care is taken to secure that the neck of the bottle is always full of milk, so that there is no air-space between the milk and the tube. When a baby is sucking, it creates a partial vacuum; it removes some of the milk, and air cannot replace the milk while it is sucking. The result is that it becomes increasingly difficult for the baby to obtain milk, and a vigorous baby will go on till he is compelled to release the teat, because he cannot get the milk. The teat then collapses, and partially shrinks into the bottle; the air passes into the bottle, and relieves the vacuum; the teat is released from the suction pressure, and the infant can proceed. That is an important detail in feeding a baby. We must replace in some way the natural resistance. One of the greatest mistakes is to use a bottle fitted with a valve which allows the air to come in at one end, while the baby gets the milk at the other. In breast-feeding there is no such valve.

Various other points of detail are worth our attention. A feeble baby, of course, has to be considered. You must allow a larger hole in the teat for such an infant. A baby should take not less than fifteen minutes for its feed, and therefore the teat should be adjusted accordingly, the object being to ensure that instead of a large bulk of milk falling into the stomach suddenly, a gentle stream flows into the organ, and becomes intimately blended with the gastric juices.

Another very important factor is the *interval* of

feeding. A quite young baby should be fed every two hours. At about three months of age that should be changed to an interval of two and a half hours. If food is received by a baby before the processes of digestion of the last meal are finished, this is extremely liable to upset digestion in the stomach. Therefore, it is advisable to see that the interval after feeding is of sufficient duration. As soon as the infant is about three months of age, we make the interval two and a half hours, and a little later on we make it three hours.

Another factor is that the stomach should be allowed to rest; and let me impress upon you the importance of training a baby, as far as possible, so that it goes during the greater part of the night without food, after it has reached the age of two months. We should manage to take a baby at about this age from 10 p.m. to 6 a.m., or thereabouts, without food. I do not give that advice without the caution that it cannot be universally applied: there may be infants who cannot go so long; but other things being equal, it is well to let the baby sleep at night for as long as possible without food. As a rule, a baby managed in that way does much better, because the whole digestive system has the rest that it requires.

Then we come to the question of the vomiting of the curd some time after food, which is such a frequent sign of disorder, as we see it in infants. That is a symptom which should never be neglected. It means that the food is wrong; it means that the whole digestive processes of the stomach are becoming

perverted, and it means that we should deal radically with the symptoms by treating the cause. In practically all these cases, the vomiting is due to the fact that the food the baby is receiving does not compare with mother's milk of a good quality, does not meet the requirements of an infant's food, and is being vomited by the baby because it can do nothing else with it. The injuries that are finally sustained when this vomiting is allowed to continue for a considerable period are very serious. Very often, after a period of gastric disorder of this kind, intestinal disorder arises, and then we have the baby very ill, its stomach out of order, its intestine also out of order, and we are compelled to use the greatest efforts to get this put right, handicapped as we are by the fact that the whole alimentary canal is in a pathological condition. If the vomiting is allowed to continue, a very troublesome condition arises—dilatation of the stomach. It is one of the most difficult and tedious conditions to treat in a baby. Dilatation means that the stomach wall is stretched, that it has less than its normal contractility. It is no longer the healthy organ it was: at times it is allowing masses of food to ferment without vomiting; at other times large amounts of curd and fluid are vomited. For the treatment of this atonic condition, where the stomach is stretched and loaded with fermenting materials, one has very often to resort to the method of stomach-washing, by means of the stomach-tube. It is useless to put any good food into a stomach in the condition I have described, and therefore we pass in a tube, and through the tube

pass into the stomach some ounces of water, according to the size of the stomach and the age of the infant. We then allow that fluid to flow back, and wash out the stomach two or three times, so as to get it clean, and in as healthy a condition as possible, before administering food. In these cases it is the amount of proteins or fat material that is generally the difficulty. Inadequate amounts of fat or proteins do not, as a rule, cause vomiting; but when there is excess of proteins, the stomach vomits them, and, in addition, there is another tendency likely to arise. As a result of this constant vomiting, the stomach becomes highly irritable, so that when you proceed to give a proper food, you may find that the infant has a marked tendency to vomit.

I have already referred to the cardinal point in the treatment of vomiting, characterized by the expulsion of large amounts of clear fluid. As a rule, after a brief preliminary treatment, one has to give a fair amount of fat, and in order not to irritate the stomach, a small amount of proteins; but in all these cases where you find the regurgitation of clear fluid a considerable time after feeding, you should remember that it is the general condition of the infant which most requires attention, and as soon as the general nutrition of the infant has improved, this symptom will gradually disappear.

There is another condition of the stomach which has given rise to a great deal of discussion in the medical profession, and about which many different opinions are held. It is known as congenital pyloric stenosis. There are other names, but that is the one

by which it is most commonly known. It is a remarkable condition, in which there is a spasm of the pylorus, so that when food attempts to pass from the stomach to the intestine, the pylorus comes into a condition of spasmodic contraction, and prevents the passage of the food. As a result of that, dilatation of the stomach ensues, associated with vomiting. In the typical cases the vomiting is rather characteristic, because it is not after every feed, nor does it necessarily occur every day, but at periods of about every twenty-four or forty-eight hours large amounts of food are vomited, while at other times the baby takes its food without vomiting.

Another characteristic feature of these cases is the marked tendency to constipation. We therefore have a somewhat remarkable clinical picture. Very often you will find that the stomach is dilated, so that you can not only palpate it, but you can see the stomach rising in the abdomen of the infant, so that it looks like a hen's egg protruding from the abdomen. It is a very interesting class of case, and one of the most interesting features to me is that one of its cardinal features has never been referred to—that is, that most of these babies are just under the length of the normal infant at birth; not very much under—they are not less than 18 or 19 inches, but they are not 21 inches; they may be 20 inches, and very often 20½ inches. It is as well, therefore, as these cases should be recognized early, that I should describe the characteristic features to you.

The opinion is held very strongly by many experts that there is an organic stricture of the pylorus—that

is to say, there is an amount of material in the region of the pylorus which is altogether pathological, which amount of material is responsible for the obstruction. Without going into all the details of the matter, I am confident that the great majority of these cases are not due to that condition at all. Nor do I think that the spasm of the pylorus is the most important feature of the disease. The cardinal feature, in my opinion, is the dilatation of the stomach. In a baby weak at birth, born in a condition of some slight defect—I impress upon you the defect is slight, but nevertheless it is there—there is a greater tendency for the stomach to stretch than in the normal infant. The pylorus only contracts and relaxes at intervals. It is its function to protect the intestine from the passage of food materials at wrong times. Whenever vomiting occurs, it can only be effected by the pylorus closing. If the pylorus were not to close, the stomach would force the food into the intestine. So the contraction of the pylorus is a normal process. The baby I am describing is peculiarly liable to gastric distension ; if the food is unsuitable, dilatation rapidly occurs. The development of the pyloric spasm is greatly contributed to by the distension of the stomach. The greater curvature of the organ is much enlarged, so that there is a marked disturbance of the anatomical relations. In the stomach, so dilated, the food lodges in a cul-de-sac at a level *below* the pyloric opening. The great cause of the spasm is, in my opinion, the dragging of the loaded stomach on the pylorus, with the result that it is in a condition of chronic spasmodic contraction, and,

when it does relax, the stomach has great difficulty in passing food through it.

Those features are interesting, because it is a subject of controversy in the medical profession at the present time, whether these cases should be operated on or not. Some physicians hold that this is an organic stricture, opposing the passage of food, and an operation has been designed by which the intestine is joined to the stomach, obliterating the region of the pylorus. Not long ago a case was sent to me by several doctors, who had seen it in consultation in a country town, and (although I did not know this had been said) all the doctors advised the mother that if I recommended operation, she was to take the advice, as she might be sure nothing else could save the baby. Well, I am not in favour of operations on these cases, and I sent the baby into the Infants' Hospital. Simply by adjustment of the diet, and the necessary care of the baby, we were able to cure the pyloric spasm and the dilatation of the stomach, and so obtain a good recovery without any operation at all. So I think you will agree with me that it is important to recognize these cases as early as possible, and I will recapitulate their cardinal features.

The baby is slightly defective, and has as a rule been about 20 or 20½ inches in length at birth. It is a young baby under four months of age, and generally under three months, and its length has but slightly, if at all, increased. The symptoms begin early, and very often occur in breast-fed babies. The vomiting is irregular, sometimes being a marked feature, and at other times much less marked.

Dilatation of the stomach is always present. Constipation is almost invariably present, and I may also mention that the baby generally presents a somewhat shrivelled and dry appearance.

The stomach acts as a check on the entrance of the food into the intestine, and does not play a very essential part in the actual processes of digestion. This is the work of the intestines, and particularly of the small intestine. Into the duodenum the liver pours its secretion. The powerful digestive ferments are elaborated in the pancreas, and pass into the intestine as the food arrives from the stomach and provides the secretive stimulus. Its duct joins the duct from the liver, and together the digestive secretions from these two organs pass into the middle part of the duodenum. We have to deal here with processes of a remarkable chemical and physiological character. One of the characteristics of the intestinal dejections of the infant is that they are largely by-products thrown out by the liver, the pancreas, and the mucous membrane of the intestine. The yellow colour of the normal dejections of the healthy infant is due to pigment in the bile, and when the motions become pathological, and the colour becomes green, it is due to the oxidation of one pigment (bilirubin) into another form (biliverdin). Consequently, the study of the processes involved in intestinal digestion throws light on the actual processes as they are proceeding in the individual infant. That is the reason we pay particular attention to the character of the dejections. In this hospital, for instance, the babies are fed on food the elements of

which are in strict accordance with the prescriptions, so that we know exactly what the infant is receiving, and we infer the nature of the intestinal processes from examination of the dejections.

The normal dejection should be light yellow in colour, like loosely-mixed mustard, without odour, except, perhaps, a slight stale odour, and they should be moderately loose, certainly not formed. Let us contrast these features with those characteristic of intestinal disorder. The first thing we notice is the large amount of mucus, indicating inflammation of the whole tract of the intestine, and particularly of the large intestine. Very frequently that is associated with lumpy material, often described as curd; and it may be so, but it is very often mucus combined with the sloughs of ulcerative lesions in the colon. In such cases, where intestinal disorder has been present for some long period, chronic colitis results. This requires great care in the treatment, and a considerable period before it can be cured. Mucus is an indication of irritation affecting the intestinal mucous membrane. It is largely seen in older babies suffering from rickets.

As regards the colour of the dejections I may mention an important point, and that is—as long as there is any yellow a small amount of green is not a serious indication. The yellow colour will frequently change to green if the dejection is exposed to the air, and in those cases where a definite yellow shade can be detected the dejections need not necessarily be pathological at all. We should carefully distinguish between such dejections containing any yellow

colour and those that are grass-green in colour, resembling chopped spinach. These last are always pathological.

Another characteristic of chronic intestinal disorder is that the dejections are markedly offensive, owing to the putrefactive changes which occur in the intestine, leading to ammoniacal decomposition of the food products. In these cases it must be remembered that the vital activities of the intestine have been largely replaced by processes altogether foreign to those characteristic of the healthy infant. As a result of the disorder, the liver is no longer pouring out the secretions, the pancreas has largely ceased to act, the intestine itself is yielding but a poor supply of the juices it freely secretes in normal circumstances, and the food material of the intestines is simply a mass of material undergoing putrefactive changes, just as it might do outside the body; but the putrefactive changes are greatly intensified by the fact that the decomposing material is maintained inside the infant at a temperature of about 100° F. The result is that all kinds of pathological signs in the dejections are observed, while the absorption of the products produced by these decompositions poison the infant, and are largely responsible for the anæmia, pallor, and unhealthy appearance of the infant so suffering.

Obviously, then, in such cases the first object of treatment must be to get rid of these products. I have to-day admitted eleven babies, and in most of these cases there is a prescription that a dose of castor-oil should be administered immediately, the

simple reason being that it is of little use to put good food into a mixture of decomposing material. In severe conditions, as seen in most of these infants, it is hardly likely that one dose of castor-oil will put an end to the pathological processes, and so we administer some drug which will counteract, as far as possible, these putrefactive changes. The only drugs which attain this end, that I know of, are the drugs that stimulate the liver. I dare say you will have heard of a large number of intestinal antiseptics as being of great service. None of them, in my experience, do any good. But there is one drug of the very greatest value, and that is mercury in the form of grey powder or calomel. It does not matter, as a rule, which you use; in some cases one is better than the other, but they are both extremely useful drugs, and in the preliminary treatment of intestinal disorder nothing, that I know of, can replace them.

Where there is a great deal of colitis, or of mucus, due to inflammation of the intestinal mucous membrane, irrigation of the colon is very often of value, particularly where the infant suffers from continuous dejections, which are exhausting it. In such cases irrigation of the colon for one or two days will often speedily relieve the infant, and do more to secure its recovery than almost anything else.

A source of difficulty in the treatment of these cases is that, when the disorder has persisted for some time, the intestine becomes very weak and atonic. It is a common feature in this hospital to find that, after the baby has been in the hospital a few days, the Sister

draws attention to the fact that the abdomen is distended—so much so that it is quite tense and tympanitic, and the intestine is filled with gas, as the result of the paralysis of the muscular wall of the intestine. Again, in these cases irrigation of the colon is very desirable, and we are accustomed to add to the water some turpentine, to stimulate the contraction of the intestine.

As regards the dietetic treatment of these cases, it proceeds much on the lines I have laid down in my previous lecture on Atrophy. The first thing is to begin with a dilute food which is within the power of the baby. If that food agrees with the infant, and does not give rise to disorder, then it is acting as a powerful stimulus on the liver and pancreas. They will secrete their juices, and when they are performing normal functions, then we shall be able to provide the baby with stronger and better food day by day. By attempting to press the food, we shall only defeat our own end, because directly the amount of food passes the limit of toleration, the whole alimentary system at once gets out of order, the liver stops working, and the processes degenerate again into the putrefactive changes which I have described.

One other point I may mention in conclusion. In older infants, where there has been disorder for some time, you may find the dejection of the infant absolutely white, looking like the curd of milk, without a trace of yellow and without a trace of green. That is generally a serious indication. It does not occur in young infants, but in infants about

nine months of age. It is characteristic of the rachitic condition, and it means that the liver has entirely ceased acting for the time. The liver does not cease acting without some good reason. As a rule, that is only one of the later phenomena of injurious processes that have been going on for a considerable period. It is well to caution you that, when you observe dejections of that character, the infant may become seriously ill, unless great care is taken.

Thus we arrive at the end of our present course. There is much that has been left unsaid: there is a great deal that is incomplete and fragmentary. But I hope I have succeeded in portraying to you some of the more important features of disease and disorder as they are to be observed in the critical period of infancy, and in assisting you to approach their study from the standpoint of scientific medicine.

Remember that babies will be your joy or your despair, according to your powers of observation—for they cannot speak.

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